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SOME EVERYDAY APPLICATIONS OF ACOUSTICAL PRINCIPLES.[1]

BY F. R. WATSON,

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One of the everyday axioms concerning fishing is not to talk. "Don't talk or you'll scare the fish" is the usual statement. This caution is well founded because when people talk, experience shows that the fish become scared. They become frightened, however, for a different reason than the one assigned.

Theory shows conclusively that sounds generated in the air are reflected almost totally when they reach a surface of water, so that little likelihood exists that any appreciable amount of the sound produced by talking enters the water. Search must be made further for the cause of the fright of the fish. The explanation is found in the action of the sounds set up in the structure of the boat that contains the fisherman. Thus, the scraping of feet, the rattling of oars or other objects creates a disturbance that passes easily through the boat into the water with very little loss of intensity.

The explanation is now quite simple. When a fisherman talks, he usually moves about somehwhat to relieve the physical strain of sitting still. This bodily movement is likely to set up some disturbance in the boat, and this latter action is what disturbs the fish. The writer has verified this theory by experiment. Sitting still in a boat and talking loudly produced no effect on the fish, but the slightest scraping of the feet on the bottom of the boat sent the fish rapidly away. A further confirmation has been given to the writer by a man who has witnessed the hunting of whales in Arctic waters. Success in getting close to the whale is attained only by observing the greatest precautions to avoid generating sounds in the water. Either the boat is propelled by

[1]Read before the Physics Section meeting of the Central Association of Science and Mathematics Teachers at Lake View High School, Chicago, November 29, 1919.

sails with suitable silencing of the yard arms, or by rowing, in which case the oar locks are muffled and the sailors' shoes are wrapped in cloths to prevent accidental scuffling. At the same time, all of the persons in the boat may talk as much as they please.

The principle just described furnishes the explanation for another everyday phenomenon; namely, the insulation of sound in buildings. When a sound travels through the air to a plaster wall of some thickness, it is almost totally reflected. Calculations show that only about three parts in a million of the incident sound get through a solid plaster wall 2½ inches thick. Such sounds would be generated by the voice, a violin, etc. In case, however, the source of sound makes an intimate contact with the building structure as, for example, a piano resting on the floor, the vibrations will travel with ease through the continuity of structure and may appear surprisingly audible at some distant point in the building where a resonant surface transmits the vibrations to the air.

Sound is a wave motion and is subject to the general laws of wave motion. It progresses with small loss in intensity in a homogeneous medium, but on encountering a second medium differing in density or elasticity, it suffers a partial reflection and refraction, the relative amounts of which are proportional to the abruptness of change of elasticity and density. For instance, referring again to the insulation of sound in buildings, it is found that sounds generated in air will travel almost unchanged as long as the medium remains unchanged. A sound generated in a room passes easily to other rooms and distant points in a building through ventilation ducts, open doors and halls, or generally, wherever a continuous air passage is presented. On meeting an obstacle, however, the sound is hindered in its progress as already explained for the case of a plaster wall.

When an air passage becomes narrow, a new phenomenon appears in the creation of a friction between the walls of the passage and the vibrating air particles that propagate the sound. This friction transforms the sound energy into heat. According to this reasoning, a wall crack will not transmit much sound. If the wall is fairly thick, sound entering one side in a crack will be damped out by friction before passing through. The crack or aperture must have some area of cross section to allow transmission. This statement may be verified by noting the increase in sound when a window is opened suddenly as a street car or other noisy vehicle passes by. Closing the door to a room where

a typewriter is sounding will show a corresponding reduction of sound.

This action of friction has other applications. The efficiency of hair felt as a sound deadener in auditoriums is due largely to the friction generated in its pores. Calcualtions show that a layer of hair felt 10.4 inches thick will completely extinguish a sound of average intensity and thus allow none to be transmitted. A heavy rug because of the interstices between its fibres will set up a similar friction for sound waves and for this reason possesses a considerable deadening effect. The writer has calculated the amount of heat generated in an ordinary rug three feet by five feet in area when the sound of an average speaker falls upon it for thirty minutes. This gave the value .00001 calorie, indicating that the energy of sound is quite small.

Another question might be asked in this connection concerning the ultimate fate of sounds that proceed upward. The answer is found again in the action of friction, because the sound is stifled in attenuated air in the upper reaches of the atmosphere.

A further action of sound that produces many phenomena of everyday occurrence is diffraction. We read in textbooks that a train of waves proceeding through a narrow aperture will be spread out as if coming from a new source of waves. An open window illustrates this action. The window is a narrow opening for many outside sounds because these may be heard in all parts of a room, thus indicating a diffraction or spreading of the sound as it enters. The action is modified somewhat by the reflection of sound from the walls of the room.

If the aperture is wide compared with the wave length, it produces but little effect on the waves and they progress almost unchanged. Following experiments suggested by Lord Rayleigh[2] the writer[3] has developed a megaphone with a rectangular aperture. Speech waves emerging from this megaphone are spread sideways by the narrow dimension, but scarcely affected by the wide dimension as shown in Figures 1 and 2. The diffraction is further illustrated in Figure 3 where circular water waves proceed simultaneously through a narrow and a wide aperture.

This megaphone is useful in a number of situations. Of particular interest to educational institutions, it may be used to address a crowd of people on bleachers at an athletic meet. It has an advantage over the usual cone shaped megaphone. The latter instrument directs sound to a favored few on the line of

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[2] *Philosophical Magazine*, Vol. 6, page 289, 1903.
[3] *Physical Review*, Vol. 11, page 244, 1918.
Scientific American, May 24, 1919.

its axis, while the rectangular megaphone spreads the sounds into a fan shaped zone that reaches all the auditors on a set of ordinary bleachers.

The action of the megaphone is reciprocal, that is, it may be used as a selective receiver. Sounds of sufficient intensity generated in the fan shaped zone just described will be heard by the ear placed at the small end of the megaphone, while sounds

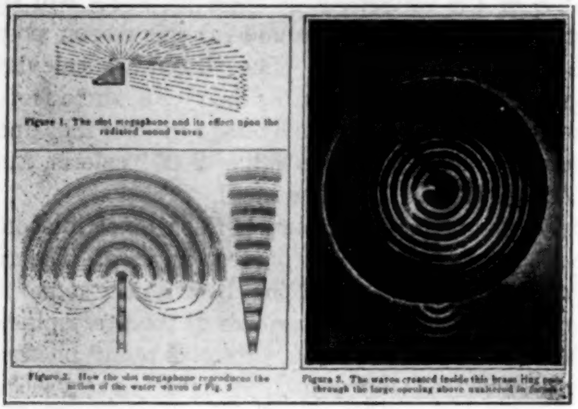


Figure 1. The slot megaphone and its effect upon the radiated sound waves

Figure 2. How the slot megaphone reproduces the action of the water waves of Fig. 3

Figure 3. The waves created inside this brass ring pass through the large opening above unaltered in form

outside this zone will not be so received. This receiving action allows a systematic search of the sky to be made for airplanes. The megaphone has other uses, but enough has been given to illustrate its action.

In conclusion, a statement should be made concerning the choice of illustrations in this discussion. They were chosen with the hope that they might be of some use in teaching the subject of sound and also, that they might stimulate efforts to explain other every-day phenomena by scientific principles.

SIX THOUSAND TONS OF ARSENIC.

The white arsenic produced in the United States in 1918 amounted to 6,323 short tons, valued at $1,213,000. By far the greater part of the domestic white arsenic consumed in the United States in 1918 was used in preparing insecticides and weed killers, the total quantity so used in 1918 being about 2,000,000 pounds, according to the United States Geological Survey, Department of the Interior. Nearly 1,000,000 pounds was used in the glass industry, and a small quantity in the preparation of drugs.

The production of gold, silver, copper, and lead in South Dakota and Wyoming during the year 1918 is reported by Mr. Charles W. Henderson, in a publication recently issued by the United States Geological Survey, Department of the Interior. This report, which is a chapter of the Geological Survey's volume on "Mineral Resources of the United States, 1918," reviews briefly the situation in the producing counties of these states and records significant new developments. A copy can be obtained from the Director, United States Geological Survey, Washington, D. C.

THE AUTOMOBILE IN PHYSICS.[1]

By H. C. Krenerick,

North Division High School, Milwaukee, Wis.

The content of physics is constantly changing. The physics teacher, as no other, has the ever present task of keeping up with the times. Our textbooks and textbook writers are too conservative. Never before have we had an invention or physical appliance so universally used, so composite of physical principles, as the automobile, and yet practically all textbooks in use make no mention of that worthy institution.

Whenever new subject matter is suggested, the objection always raised is that there is no time, that the course is already overcrowded. The conclusive answer to such objections is that there is always room for the most essential things. We still find in our modern texts cuts and discussions of drum and ring wound armatures, unipolar and multipolar dynamos, Westinghouse air brakes, hydraulic rams and elevators. But what part of our boys and girls ever come in contact with them? Compare the interest and instructive value of such applications with those found in the automobile. Practically every principle we teach in heat and electricity finds its application in the modern automobile.

For the first few years of my efforts to use the automobile as a source of application of the principles of physics, I depended on lantern slides of cuts and diagrams. But these were inadequate in some cases compared with the real thing. Two years ago, I included in my requisition for supplies an old incapacitated automobile, to be purchased when I found one suitable for my purpose. The intention was to remove the body, take apart the chassis, thoroughly clean and reassemble it in my laboratory. Not much floor space was available, so a small car was necessary. It was essential also that it be somewhat modern in its improvements.

The country had just entered the war, automobile manufacturing was soon limited and any old car was in demand for some kind of service. I went the rounds of the auto wrecking establishments and second-hand dealers many times, advertised in papers, interviewed automobile dealers, and argued that it would be most excellent advertising. They admitted that it would and promised to keep the matter in mind. The "Want and Ad" columns of the papers were always searched and after many

[1]Read before the Physics Section of the Central Association of Science and Mathematics Teachers at Lake View High School, Chicago, November 28, 1919.

months the opportunity finally came. The last of September I was able to get a Monroe roadster, 1917 model, a complete and modern car in practically every respect.

With the aid of a couple of boys on Saturdays the body of the car was removed, the chassis completely dissembled and cleaned. Before reassembling the chassis in the laboratory, many parts of the castings and housings were cut away that the working mechanism of all parts might be revealed. Originally, I had no thought of cutting away the parts by hand, but after a few unsuccessful attempts to have it done at some machine shop, I tried a hack saw. I was glad to be able to do it so easily by hand. It took a good many hours' work, but it is more extensively cut away and more to my satisfaction than had it been done by a machinist.

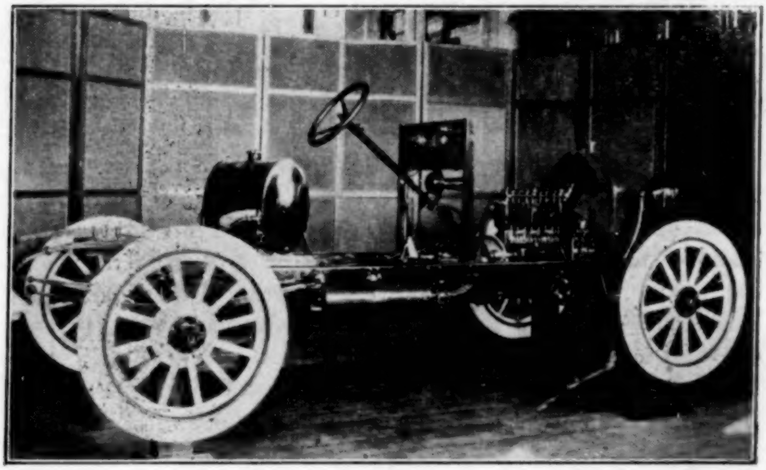
I have a few slides of the chassis as it is now set up in my laboratory. They do not do it justice, however, I would need color photography to bring out the different colored paints used. The different colors were used for an instructive rather than decorative purpose. The entire gasoline system, including the tank, carburetor, intake manifold, intake valves and rods are painted red. The exhaust valves, rods, mainfold and muffler are yellow. The water passages and radiator are blue. The same color plan is used as an aid in tracing the electric circuits. The starter circuit wires are painted black; the charging circuit is blue; the primary circuit is yellow; the secondary circuit is red.

Castings and housings have been cut away so that the pistons, valves, cam shaft, crank shaft, clutch, gear set, driving shafts, roller bearings and differential are seen in action. The wheels are supported from the floor so that all of the mechanism may be kept running by means of the storage battery and starter. Steering gears and the internal expanding brakes have also been exposed by cutting away parts of the housing. All parts are thoroughly cleaned and can be easily taken apart or assembled for class-room study or demonstration.

At least three laboratory exercises will be given on the chassis. One experiment will be to trace and diagram the electric system. With the different circuits in different colors, this will not be a very difficult task. Fortunately, the system used on this particular car is the Connecticut Autolite, one of the most simple used.

A second experiment will be to determine the horse power of

the engine by the S. A. E. rating (H. P. = $D^2N/2.5$). Also by the complete formula: H. P. = $(P \cdot A \cdot S \cdot N \cdot E)/(4 \times 33{,}000)$. Assuming, as is claimed, that the engine is most efficient at 2,400 revolutions per minute, find the piston speed (S) in feet per minute. The average pressure (P) is taken as 90 pounds to the square inch, and the efficiency of transmission (E) as 75 per cent. In this experiment the cylinder head with its valves, etc., will be removed and later assembled by the student.



A third experiment will be to apply the principle of the wheel and axle to the various gear wheels in the transmission from crank shaft to rear axle, and determine the gear ratio of the different speeds. From these results and the circumference of the rear wheel, determine the speed of the car in miles per hour at which the engine will be at its maximum efficiency, 2,400 revolutions per minute. Also with a pressure of 90 pounds to the square inch, and a transmission efficiency of 75 per cent, find the maximum road resistance at rear wheels.

After our textbook study of the steam engine, I like very much to spend a day or more on the steam automobile because of the interesting and excellent illustration of many of the principles of heat. A set of twelve slides was made from cuts and diagrams obtained from the Stanley Automobile Company. The complete condensing system used on the latest model, the various automatic controls working on some principle of heat, the different fuel systems, the type and construction of the boiler, the double action engine, the simple illustration of the eccentric reversing mechanism, the comparative ease of control, all make it a very interesting and profitable study.

CHEMICAL WARFARE SERVICE AND CHEMICAL TEACHING.

By William McPherson,

Ohio State University, Columbus, Ohio.

I propose to discuss the subject assigned me by your program committee under two heads. In the first place I will give a brief account of the work carried on by the Chemical Warfare Service, or rather, since the time is limited, with that part of it with which I am most familiar; and in the second place I will endeavor to point out how the experiences as well as the achievements of chemists during the war should influence for good the teaching of chemistry in our schools and colleges.

I. The Work of The Chemical Warfare Service.

The organization of Chemical Warfare Service as a separate branch of military service was the culmination of an effort to utilize, in the most effective way, the services of the trained chemists of our country in the winning of the war. This branch of the army had to do largely with the production of poison gas and the means of combating it. It also rendered services in many other lines of work, such as in the investigation of certain chemical substances for the production of clouds and smoke screens. Incendiary bombs, rockets and flares also came within its province. My own connection with the Service was confined almost entirely to the production of toxic gas and my remarks therefore will be confined largely to this phase of the work.

The first gas attack in the great war was launched by the Germans on April 22, 1915. The story is well known and need not be repeated here. Nearly two years elapsed between the date of this first attack and that of the declaration of war by the United States. Unfortunately, but little attention was given to this new method of warfare in our country during this interval. When we finally entered the war, gas warfare was on a thoroughly established basis. The War Department therefore was immediately faced with all the problems connected with its development. Suitable gas masks had to be made in large quantities. Methods for the production of toxic gas on a large scale had to be worked out and put into operation. Gas shell as well as the necessary machinery for filling these shell with the toxic materials had to be developed—all at the earliest possible moment. The enormity of the problems was foreseen. Gases, the preparation

[1]Read before the Chemistry Section of the Central Association of Science and Mathematics Teachers at Lake View High School, Chicago, November 29, 1919.

of which even in small quantities was prohibited in many laboratories, because of the danger incident to this preparation, were now to be manufactured in quantities of many tons daily, loaded into shell and shipped to our armies in France.

At this time the War Department did not have available the personnel and facilities for even carrying on the research work necessary for the development of gas warfare. The only laboratories at all adapted for this sort of work were those connected with the different arsenals, and these were already overcrowded with work connected with the problems of the arsenals. In February, 1917, two months before the United States declared war, the Bureau of Mines, anticipating the declaration of war and cognizant of the fact that the experiences gained by the Bureau in an extended study of mine gases would be of value in the investigation of this larger question, offered its services to the War Department. Later this offer was accepted and to this Bureau was assigned the task of carrying on the necessary research work. The production of toxic gas and the filling of this into shell were assigned to the Trench Warfare Section of the Ordnance Department. The research work originally assigned to the Bureau of Mines, the production of toxic gas and the loading of this into shell, as well as the production of gas masks, were all combined finally into the Chemical Warfare Service as a separate unit of the National Army.

It was the original intention to interest existing chemical firms in the manufacture of the required toxic materials, with the hope of obtaining from such firms the entire supply required. As the work developed, however, difficulties arose in carrying out this program. The manufacture of such material at private plants necessitated its shipment to the United States filling plant for filling into shell, and the transportation of large quantities of highly toxic gases would naturally be attended with great danger. After due consideration, the Director-General of Railroads ruled that all such shipments must be made by special train movements—a very expensive method of transportation. Still more serious objections, however, were encountered in the efforts to enlist the cooperation of existing firms. It was recognized by these firms that the manufacture of such materials wou'd be attended by very great danger; that the work would be limited to the duration of the war; and that the processes involved, as well as the plants necessary for car.ying out these processes,

would have little post-war value. Moreover, such firms as had the personnel and equipment for carrying on this kind of work were already overcrowded with orders; with few exceptions, therefore, they were unwilling to undertake work of this character.

As soon as it became evident that the necessary supplies of toxic gas could not be obtained in whole from existing firms, it was decided to build certain Government chemical plants. The question of their location had to be answered immediately. The Government had recently taken over a large tract of land near Edgewood, Maryland, about twenty-five miles out of Baltimore on the main line of the Pennsylvania Railroad running between Baltimore and Philadelphia, as a proving ground. A part of this tract (about 3,400 acres) had already been set aside as the location of the U. S. Filling Plant which was being built for the purpose of loading toxic materials into shell. It was recognized at once that this was an ideal place for the building of at least some of the chemical plants, thus avoiding the shipment of the toxic materials; accordingly, by December 1, 1917, it had been definitely decided to build at Edgewood two plants—one for the production of chlorpicrin and one for the production of phosgene. Later the U. S. Filling Plant became known as Edgewood Arsenal, and here was developed an enormous death-dealing industry. In addition to the Government plants at Edgewood other Government gas plants were located at Buffalo, Niagara Falls, Kingsport, Tenn., Stamford, Conn., Hastings-on-Hudson, N. Y., Midland, Mich., and Bound Brook, N. J. The choice of location was based primarily on availability of facilities at the places designated.

Since it is impossible to go into detail in regard to the subject, I will briefly review the projects carried out or in process of completion at the time of the signing of the armistice.

(*a*) *The Production of Chlorine.* Chlorine is the chief of all materials used in the manufacture of toxic gas. It bears the same relation to the manufacture of toxic gas that nitric acid does to the manufacture of explosives. It was not only used directly in wave attacks, but it is a constituent of nearly all toxic gas. Fortunately, chlorine had long been used in the United States and its manufacture was on a thoroughly established basis before war was declared. The pre-war production was close to five hundred tons daily, most of which was used in making "bleach." It soon became evident that large additions would have to be

made to the chlorine output in order to meet the gas requirements. After a thorough study of the problems involved, it was decided to build a plant at Edgewood, with a capacity of one hundred tons daily. The cell used (Nelson) in the plant is operated by a current of 1,000 amperes and 3.8 volt and has a capacity of 60 pounds of chlorine and 65 pounds of caustic soda per twenty-four hours. The current required for electrolyzing the salt was obtained partly from the hydro-electric plant at McCall's Ferry, Pa., and partly from local generators. Construction on the plant began on May 11, 1918, and the first unit was ready for operation on August 1 of the same year.

(*b*) *Chlorpicrin* (CNO_2Cl_3). This compound (boiling point 112°) is made by passing live steam through a mixture of bleach and picric acid. It was the first of the toxic materials to be produced in the United States on a large scale. The Government had two plants; one at Stamford, Conn., and one at Edgewood. The former came into production first, a shipment of over 100,000 pounds being made from this plant on March 11, 1918. When the armistice was signed these two plants had a monthly capacity of 3,000,000 pounds. There was actually produced 5,552,000 pounds, of which amount 3,806,000 pounds were shipped overseas.

It should be noted here that the chemical plants of the Arsenal were never operated at full capacity, and indeed were often shut down because of lack of shell. The largest part sent overseas was shipped stored in large drums and filled into shell obtained from our Allies.

(*c*) *Phosgene* ($COCl_2$). This gas (boiling point 8°) is made by passing a mixture of chlorine and carbon monoxide in molecular proportion over some form of porous carbon which acts as a catalytic agent. The Government had three plants for its manufacture ,one at Niagara Falls, in connection with the phosphorus plant of the Oldbury Electro-chemical Company, one at Bound Brook, N. J., and one at Edgewood. The process of production in these three plants differed in detail only in the method of producing the carbon monoxide. In the Niagara Falls plant, the carbon monoxide was obtained as a by-product in the manufacture of phosphorus, at the Bound Brook plant it was made by passing oxygen over carbon, while at the Edgewood plant it was produced in large quantities by passing a mixture of oxygen and carbon dioxide over carbon. The total production of phosgene at these plants up to the date of the signing of the

armistice was 3,233,070 pounds, of which amount 840,000 pounds were shipped overseas. The monthly capacity of the three plants on November 11, 1918, was 2,100,000 pounds, and enlargements were nearly completed which would have increased the capacity to 3,300,000 pounds by January 1, 1919.

(*d*) *Bromine.* This element is essential to the production of that type of gases known as lachrymators or tear producers. The pre-war production of this substance was limited, amounting to less than 1,500,000 pounds annually, about two-thirds of which was produced by the Dow Chemical Company of Midland, Mich. This supply was entirely inadequate for war purposes. It was decided, therefore, to enlarge the supply and inasmuch as the richest bromine bearing brines are found near Midland, Mich., a contract was made with the Dow Chemical Company to sink seventeen wells and separate the bromine from the resulting brine. This work was completed and the wells are now the property of the Government and are capable of producing 650,000 pounds of bromine annually, or nearly one-half of the pre-war production.

(*e*) *Dichlorethyl sulphide* $(C_2H_4Cl)_2S$, commonly known as mustard gas. This compound when pure is a colorless or slightly yellow oily liquid boiling above 200°. It was first used by the Germans in 1917. Later it was recognized to be of the greatest importance and every effort was made by the Allies as well as the central powers to manufacture it in large quantities.

The Government constructed three mustard gas plants as follows: (*a*) One at Buffalo in connection with the National Aniline and Chemical Company; (*b*) one at Hastings-on-Hudson, in connection with the plant of Zinnser and Company; and (*c*) one at Edgewood.

Only the latter came into production by the time of the signing of the armistice, although the other two were practically completed. There was made at this plant 1,422,000 pounds, and of this amount 380,000 pounds had been shipped overseas. The total monthly producing capacity of the Government plants on November 11 was 1,800,000 pounds or three times that of the German plants. By January 1, 1919, had the war continued, the Government plants could have produced 8,000,000 pounds monthly.

(*f*) *Brombenzylcyanide* $(C_6H_5CHBrCN)$. This compound when pure is a white crystalline substance, melting at 29°. It is by far the best lachrymator known. The Government built a

plant for its production at Kingsport, Tenn. This plant was completed and production began a few days before the signing of the armistice. It had a monthly capacity of 180,000 pounds.

(*g*) *Diphenyl chlorarsine* ($(C_6H_5)_2AsCl$). This is a white crystalline solid melting at 44°. It is the most effective of the gases known as sternutators, or sneeze producers. Its effectiveness depends upon the fact that, when in a finely divided state, it readily passes through the gas masks and causes violent sneezing. This necessitates the removal of the masks, thus subjecting the troops to the effects of poisonous gases used along with the diphenyl chlorarsine. The Government had begun the construction of a large plant for the manufacture of this compound, but the work of construction had not progressed far when it was stopped because of the armistice.

A little contemplation will suffice to make one realize the difficult problems involved in the filling of shell with poisonous materials. It was essential that the work be done automatically and that the necessary machinery be placed in well ventilated tunnels, so arranged that the filling machinery could be operated from the outside—thus insuring safety to those engaged in the operation. It is only possible at this time to say that the necessary machinery for the work was invented and built and proved to be satisfactory for the work at hand.

The above projects were the main ones carried on under the supervision of the Production Division of Chemical Warfare Service. In addition to these, however, this Division was in charge of numerous other projects of a less extensive and difficult character.

II. The Effect of the War Upon the Teaching of Chemistry in Our Schools and Colleges.

During the interval that elapsed between the date of the beginning of the war and that of the entry of the United States into the struggle, even the most superficial observers could not fail to recognize the part chemistry was playing in the prosecution of the war. In many respects the contest was a chemical one in which the chemists of the opposing powers were measuring their wits against each other. England and France at first failed to recognize this fact, and many of their chemists joined the front line ranks. Later these men were called back to the research laboratories and chemical plants, but not until many lives had been needlessly sacrificed. When the United States entered the war every effort was made to avoid the mistakes

made by our Allies and to utilize the services of our chemists in places where their work would count for the most. As a result, no less than 4,000 chemists (Secretary Parsons of the American Chemical Society gives the number as 4,003) were known to be in military service on chemical assignment. No members of any profession responded more willingly to the call. From the classroom, the laboratory and the factory, chemists responded, and all through the war concentrated their tireless energy upon the solution of problems that were of vital importance to the winning of the great struggle. Included in this group of workers was a large percentage of teachers of chemistry in our schools and colleges. When the armistice was signed and demobilization came, these teachers, as a rule, returned to their classrooms and laboratories; but in many respects they were different persons from those who had responded to the call. Their experiences had developed in them new traits or augmentation of old ones that were certain to make their work as teachers more effective. Among these traits I shall mention the following:

(*a*) *Self-confidence.* No one has less regard for the blatant egotist than I. But there is a difference between the loud and generally poorly trained egotist and the individual who has that self-confidence and assurance in his own ability to accomplish important tasks. How often do we see persons who may have only a mediocre training but who believe in their own ability to accomplish results, surpass their more brilliant associates who lack this faith in their own ability. It has often seemed to me that teachers, more than any other class, lack this self-confidence. Perhaps this is due primarily to the reflection of the public mind; for I think it is true that teachers as a rule have been regarded by the public as impracticable, theoretical, bookworms. The public said as much, and we came to believe the statements—much as we came to believe the Germans when they kept telling us that we could not do certain things—make dyes for example—or as many people still believe that our dyes are inferior to those of German manufacture. But all this has been changed—largely as a result of the war. The teachers suddenly found themselves face to face with problems upon whose solution the lives of our soldiers hung. Into this work they flung themselves with all their energy. The results accomplished brought them confidence in themselves, confidence in their ability to do things, and now when the war is over and they have returned to their former duties, this re-

newed confidence cannot fail to make their work as teachers more effective.

(*b*) *Enthusiasm.* It has seemed to me that whenever I come in contact with any teacher who has done his bit in winning the war, that I have found a man or woman, (for the women certainly did their share) who has become more enthusiastic as a result of this experience. This is quite natural, for association with other workers in a tireless effort to be of service, breeds enthusiasm. Now it is entirely unnecessary for me to discuss here the part that the spirit of enthusiasm plays in a teacher's success. It is the catalytic agent, if you please, that arouses the student and incites him to activity and creates in him a desire to learn and to be a factor in the world's progress.

(*c*) *Preparedness.* It is self-evident that preparedness is fundamental to the success of every teacher. Enthusiasm without knowledge is a dangerous trait, and a teacher who is both enthusiastic and ignorant may do incalculable harm in our schools. I believe that as a class our teachers of chemistry are well trained, but of this I am certain, that no teacher passed through the experiences of war without adding greatly to his knowledge. Indeed, many, I am sure, learned more chemistry during the war than in any like period. Perhaps it was a different phase of chemistry—but this may have made it all the more valuable. Many found themselves working with the leaders of the science, and this intimate contact in helping to solve the problems presented opportunities for growth never before experienced.

(*d*) *Spirit of Work.* Many also learned the value of hard work. Night as well as day found them at their tasks. They learned to enjoy work as never before, and perhaps to their surprise they waxed and grew strong under the burdens.

(*e*) *The research Spirit.* If any one fact has been impressed upon the minds of the leaders of thought in our country, as a result of the war, it is the recognition of the part that research must play in the development of civilization. The story of the achievements during the war is largely a story of the solution of problems of all sorts and all of this work at least embodied the spirit of research. No intelligent person, the teacher least of all, could have passed through this experience without catching something of this spirit. Our teachers will return to their classrooms and laboratories with a new valuation of the part they can play in instilling into the minds of their students, something of this

spirit of inquiry which may lead many of their students ultimately to become potent factors in the world's progress.

I have already spoken of the different attitude of the public towards the teachers of chemistry. As a result, the college professor is no longer held up to ridicule for his absent-mindedness and impracticability. In the language of society, the teacher has arrived.

But the attitude of the public has been changed not only towards the teacher of chemistry; it has likewise been changed toward the science he fosters. In our appreciation of chemistry, the public today has tardily arrived to the point of appreciation of the possibilities of chemistry at which the Germans arrived years ago. It is true that some of the great industrial organizations long since have realized the fundamental importance of the science, but to the great majority, chemistry was largely an unknown field and the chemist was at most a person to be endured. But our country has suddenly awakened, and today the demand for chemists is far in excess of the supply. Indeed, one of the great dangers that is threatening the work of adequately training the students of chemistry in our colleges is the inroad that industrial organizations are making upon the personnel of our instructional force—a condition which, unless forestalled, must seriously affect the efficient training of our future chemists. As a result of this new appreciation, it will be easier to secure the equipment and supplies required for the adequate teaching of the subject.

There is another phase of this general subject that I wish to mention, viz., the possibility of arousing interest in the subject through the study of the application of chemistry to the solution of war problems. I have been greatly interested this fall with my experiences in teaching a class in elementary chemistry, several members of which have had a part in the war. It has seemed that hardly a subject has been discussed that has not been illustrated by war problems. The study of hydrogen brings up at once its use in filling dirigibles. Oxygen leads the way later to its use in making phosgene. Nitrogen opens up the whole subject of nitrogen fixation, one of the most important of war problems, and one in the study of which during the war our Government spent over $100,000,000. The true story of helium rivals the romances of Jules Verne. And so one might continue with the application of chlorine in making toxic gases, of bromine in making lachrymators, of sulphur, thousands of tons of which were

utilized in the manufacture of mustard gas. The story of the application of metals is of like interest—of sodium used in one type of incendiary bombs, of aluminum, in another type, of magnesium used in the manufacture of flares for lighting up the battle ground at night and of all the wonderful alloys of iron. How can one better illustrate the use of a catalytic agent than by reference to the use of carbon in the manufacture of phosgene or of kaolin in the manufacture of mustard gas; or how can one impress more forcibly the unsaturated character of carbon monoxide than by the property it possesses of taking up two atoms of chlorine to form phosgene, millions of pounds of which were manufactured as a toxic gas. What better example of endothermic and exothermic reactions than in the formation of carbon monoxide by passing a mixture of oxygen and carbon dioxide over carbon, as is done in the manufacture of phosgene.

A final word—the war is over but our country is faced with problems, the solutions of which are just as imperative for our country's welfare as were the problems of war. In these trying times the teachers of chemistry may well remember the attitude of that great chemist, perhaps the greatest of all times, who over a century ago uttered the memorable words—"I find it my first duty to be a good citizen of my country, and after that, a scientist."

PUBLISHERS' ANNOUNCEMENT

This journal, together with practically all other monthlies, has, during the past five or six months, been seriously embarrassed by labor difficulties, such as strikes and lack of help, also the "flu" has incapacitated many of our best workmen. These troubles have of ne essity caused our issues to be two or three weeks late in reaching the hands of our readers. We are asking you to bear patiently with us in these trials. We expe t that future numbers will be mailed promptly on or about the 20th of the month pre eding the month of issue.

SOME PROBLEMS FOR THE CLASSROOM FROM THE ORIENTATION WORK OF THE A. E. F.[1]

By C. A. Epperson,
Teachers College, Kirksville, Mo.

One of the great problems connected with the artillery work of the A. E. F. was to secure men whose mathematical training had been such that they could do simple computations in plane trigonometry by the use of logarithms. One regiment of Coast Artillery lost five officers, two of whom were Captains, by transfer to other branches of the service because they could not pass a simple examination in logarithms. In that same regiment the orientation officer seldom had at any one time more than three or four enlisted men who could compute a traverse or check his work when he had computed it. This deplorable state of affairs necessitated endless work on the part of the officers, training men to do necessary simple computations. Even then the results were unsatisfactory in that the officer never felt that he could trust the results of his new half-baked computer. The mathematical background was not there. This I know to be true of one regiment, and it is my opinion it was true to a large extent of all the Coast Artillery regiments in France.

One thing the war did beneficial to the field of mathematics was to enlist in the problems of the ordnance department a great many mathematicians of first caliber. There have been presented before the American Mathematical Society during the past year any number of papers on ballistics and kindred subjects, and the new discoveries along that line form a very interesting chapter in applied mathematics. But for the schoolroom, and I mean by that undergraduate college work, the field of ballistics has very little to offer. The formulas are largely empirical formulas obtained from the proving grounds, and our schools are not provided with proving grounds and laboratory equipment to carry out experiments. Any new investigations along these lines will probably be done on the proving grounds. Nor do the principles of gunnery as used in the A. E. F. offer much more than does ballistics for schoolroom use. Before a shot was fired, some of the corrections made were for: height of site, curvature of earth, variation in muzzle velocity, density of loading, kind of fuse used, wind, drift, jump, and atmospheric conditions. Of course the problem of height of site or curvature of earth might be presented in the classroom, but the majority

[1]Read before the Mathematics Section, Central Association of Science and Mathematics Teachers at Lake View High School, Chicago, November 29, 1919.

of the problems of gunnery would find little place there.

Before taking up the orientation work of the A. E. F. I beg leave to digress a moment. One result of two and one-half million Americans being in France was that they came squarely up against the metric system. When a soldier bought anything in France, he bought it by the kilo or liter. When he marched he marched a certain number of kilometers. When he asked the distance to any place he was told in kilometers. If he measured an angle with the transit or theodolite he measured it in grads. He soon found out that the metric system was simple. He soon learned to think in terms of kilometers. Those soldiers who did computing soon discovered for themselves the immense advantage of the metric system, and became converts to its use. They saw the advantage of dividing a right angle into one hundred equal parts instead of ninety; of dividing a grad into one hundred equal parts instead of sixty; and of dividing a minute in the same way. Some of them learned the relation of centessimal minutes to kilometers on the earth's surface. All of them learned something of the metric system. The result is that we now have in America a few ardent advocates and an immense army of young men who would welcome, or at least not oppose, a change to the metric system.

It has been the writer's observation that our academic courses in mathematics fail in two important things. One of these is that the student does not learn to appreciate the value of logarithms. He does not realize that by the use of logarithms he can carry out long and complicated computations and get accurate results. The necessity of accuracy in their use is not stressed. His use of them becomes slipshod. He looks upon them as a necessary evil he must get acquainted with to pass in his course. He complains that he can do the computations set by the textbook in less time and more easily without them. A great many times he is right. The result is that he gets through his college course with little appreciation of their value. The other fault is that the average student gets through his algebra and analytic geometry without any real conception of the value of the coordinate system. He is inclined to look upon it as something invented by mathematicians to make life miserable for him. He does not see it superimposed on maps. He is not shown the possibility of its use in measuring angles, distances and areas. He thinks of it as a system of lines with the x-axis running horizontally and the y-axis running perpendicularly, and as nothing

else. These faults may be due to the teacher, or to the textbooks, or to the student himself. But whatever the cause, they exist. To the teacher who desires to investigate, I offer the following example: set three pegs on your campus in triangular position a hundred or so feet apart. Assign to two of them, A and B, coordinates, as (75, 325) and (196, 32) and require your class in analytic geometry to determine the coordinates of the third point, C, by measuring the distances AB, AC and BC. Require an accurate check of the result. This problem will give some idea of how well your students have mastered logarithms and the fundamental principles of the coordinate system.

With the thought in mind of impressing upon the students the value of the coordinate system by showing its various uses and of teaching them to use logarithms accurately, and also in view of the fact that standard courses in surveying are given in engineering schools for all who desire to become engineers, the course in surveying at the State Teachers College, Kirksville, Mo., was converted largely into an orientation course. The first thing necessary, of course, was to teach the reading of the transit verniers and the various adjustments of the transit. The class then took up the same problems the orientation officer had in France. Since the country around Kirksville is not plentifully supplied with geodetic points, the first thing necessary was to establish known points. This was done by laying out a base line. The coordinates (5,000, 5,000) were assigned to one end of this base line, and the coordinates of the other were obtained by chaining, the base line being considered parallel to the x-axis. This, of course, gave two known points, A and B. The coordinates of a third point, C, were then determined by measuring the angles CAB and CBA. In this manner the coordinates of three other points were determined, giving six known points in all. The determining of these coordinates was the first problem and required over two weeks' time (one hour and forty minutes a day). The instructor's insistence that five one-hundredths of a yard was the maximum error allowable in the result necessitated every student in the class repeating his work two or three times. By that time the students had begun to realize that accuracy was not only possible but was a necessity. Our next problem was to check one of the points, C, by a traverse from A, closing on B. After the traverse was adjusted, the coordinates of C, obtained by the traverse, were found to differ from the coordinates obtained by intersection

by nearly one yard. This necessitated running the traverse over, with the result that the coordinates checked to within one-tenth of a yard. The average of the coordinates obtained by intersection and the second traverse were then taken as the true coordinates of C. This gave us the necessary basis for our third problem. A point, P, within the triangle ABC was chosen, and the angles APB, APC and BPC were read, care being taken to secure accuracy. The coordinates of P were then computed and checked by a traverse from A. The two sets thus obtained checked to within two inches. If the reader will solve and check this third problem, he will see that a knowledge of the coordinate system and an ability to use logarithms is imperative.

The fourth and last problem undertaken by the class was the determination of area. An area in the form of a convex hexagon was staked off and the angles and sides measured. It was then computed by dividing into triangles and summing the areas of the triangles. Then the coordinates (0, 0) were assigned to the vertex, A, and the coordinates of the other vertices determined (the x of B being 0). The area was then computed by the formula:

$$\text{Area} = \tfrac{1}{2}\begin{bmatrix} (a_1b_2+a_2b_3+a_3b_4+a_4b_5+a_5b_6+a_6b_1) \\ -(b_1a_2+b_2a_3+b_3a_4+b_4a_5+b_5a_6+b_6a_1) \end{bmatrix}$$

The class immediately recognized a labor-saving device.

The result of this experiment was expressed by one of the victims thus: "I wish ——————— (the instructor) had to compute the coordinates of every flag-pole between here and Halifax."

The attendance of students at the University of Chicago during the quarter just closed was the largest in the history of the University. The largest heretofore was that of the Autumn Quarter of 1916 just preceding the entry of the United States into the Great War. In that quarter there were 3,768 in the quadrangles and 1,169 in University College, being a total of 4,937. The registration for the Autumn Quarter just closed shows a total of 4 463 in the quadrangles and 1,219 in University College, a total of 5,682, being a gain of 745 as compared with 1916.

Professor Julius Stieglitz, Chairman of the Department of Chemistry at the University of Chicago, recently appeared before a subcommittee of the United States Senate to give evidence on the importance of establishing American independence in the manufacture of finer chemicals, especially the finer organic chemicals, which in the past have been almost monopolized by Germany. Assistant Professor Gerald L. Wendt, also of the Chemistry Department, recently addressed the Western Roentgen Society on "The Physical Factors Underlying the Use of Radium and Radium Emanation."

SCOPE OF GEOGRAPHY IN THE HIGH SCHOOL.[1]

BY JOHN CALVIN HANNA,
State Supervisor of High Schools, Springfield, Ill.

When children enter the high school they have been studying reading, writing, English grammar, arithmetic, geography and United States history for periods varying from one to six years. And they have, presumably, pretty well covered the ground of the elementary phases of those subjects, in a way and to a degree determined by the stage of maturity which they have reached in their earliest teens. These are looked upon as the fundamentals—these and besides these, if in a favored community where a fully developed elementary school system is in operation, they have in addition learned to read simple music at sight and to express themselves, with some degree of facility, in drawing.

These are the fundamentals; this achievement indicates a certain mastery of the common tools of life—language, number, expression in melodic, as well as in ordinary vocal form, and in graphic representation as well as with the written word. These are the accomplishments necessary for living at all in a civilized community, unless at a very great disadvantage and under a very heavy handicap.

He who cannot "read and write and cipher" is "out of" a vast proportion of the activities that are all about him in daily civilized life; he is dependent upon others at every turn and he is looked upon as being and he is an inferior.

He who cannot sing nor read any music, and he who is helpless with a drawing pencil in his hand, is also under a handicap; he is recognized as being partially dumb, greatly limited in his capacity for higher pleasures and in his power of expression. He must depend upon others to start the tune, to make for him an intelligent diagram.

Yes, but how about geography? Where does that come in? Why should this be included among the units of elementary knowledge? What essential thing does it supply to the one who is to dwell among civilized people?

Man is to live his life—and we try by training him in the use of these common tools to fit him for living that life.

Not only is he to live his life—but he is to live it *on the earth* and, unless he is to stumble and wander blindly and fill his days

[1]Read before the Earth Science Section of the Central Association of Science and Mathematics Teachers, Chicago, November 28, 1919.

with awkwardness and blunders, he must know something of that earth—at least of its surface and its relations to the climate, the weather, the commerce and transportation, the use and attainment of the great variety of commodities which fill his life.

This in large measure, at least as to its essentials, is given him in his elementary study of geography. He learns directions, boundaries, governments, municipalities, streams and mountains, seas and shores and the multiple forms of the earth's surface; he learns a little of the ways of the weather and the climates and the products of soil and sea and farm and mine and the relation of these to the breakfast table, and to all the luxuries, the comforts, the necessities of life; he learns of the lines of traffic and the causes of their placement.

In short, by his geography, he becomes intelligent enough not merely to read about the deeds of men and to record them, not merely to talk and write about them, not merely to sing and picture them, not merely to keep account accurately of them—but actually to *do them himself*, to be an active participant in the complex activities that spring from and develop into civilization.

Wisely then have the learned chosen these from experience as the things which the adolescent mind has become familiar with when he comes to face youth, and to enter upon its brief and golden period, soon to plunge, however well or ill prepared, into the whirling onward movement of manhood and womanhood.

Similarly, this is the land in which he is to live and he must know something of its history and institutions, at least in an elementary way.

Secondary education in the development of the race as an organized institution preceded by many centuries the formal organization of what we call elementary education.

Man in a barbarous state needed not to read and write and cipher, but he did need to be prepared for tribal membership, for what we call citizenship, by receiving a stiff training in the accumulated wisdom of his tribe before being admitted as a fully equipped citizen to the society of adults. Therefore every known barbarous tribe, when visited and studied by ethnologists, has been found to possess and maintain a fixed and thorough system of secondary education for the training of the adolescent through a longer or shorter course in the period of youth, at the end of which course, conducted in the accumulated wisdom of the tribe, imparted by word of mouth and imparted by the elders

of his tribe, with practice and tests, he shall be ceremoniously received as a man into tribal membership. High schools came first!

It was only when the accumulation of tribal wisdom grew to exceed the capacity of memory and the possibility of oral instruction, that man invented written language and number systems, and thereafter the young were "caught younger" and taught the mastery of these common tools. Then and there organized elementary education began—long after secondary education was firmly established. Such present day communities as are ignorant of this great truth, and fail to recognize it in their systems of education, are committing a great wrong and a stupid blunder.

Thus it is seen that there *is* a natural and an ineradicable distinction between the elementary and the secondary school—a line that cannot be ignored.

Vast numbers of our population stop their formal organized education at that line, alas, many of them sooner! And it is well that, whether they *must* stop for economic or other reasons, or whether they go on to inherit the birthright of every child in a free and self-governing land, it is well, I say, that this first period closes with some general knowledge and mastery of these common tools.

The adolescent at the end of grade eight, though not *well* equipped for life and its problems, has in his hand the tools whereby he may with health, energy, intelligence, and good fortune meet and solve for himself or with the aid and supervision of others many of the practical problems that await him. Furthermore, he may sometimes, and to a certain extent, acquire by himself and without formal schooling a part of that knowledge and training for a higher and richer life that secondary education would give him. And if he *can* do this or *any* of this, it is because he is fresh from a training in the use of these common tools, because the elementary knowledges and skills are his.

Then after this elementary training we wish him and her and all of them to go on, to "stick" for four years more, to acquire a secondary education.

We train him further then in the secondary school in written and oral expression; we familiarize him with some of the choicest of the world's literature; we add to and develop his mathematical powers; we give him some knowledge of the world's history and institutions, especially as these are related to those

of his own nation, chronologically and biologically; we introduce him to the great world of natural science, giving him first a bird's-eye view of the whole field and a strong impression of the universality and fixity of law in nature, and then later giving him opportunity for closer study in special fields; we give him some knowledge of another language or two, especially that he may more clearly understand and utilize his own; we open the paths of artistic expression and design; we fling wide, in these days, the doors to a pre-vocational training; we point him to responsibility and privilege in connection with civic interests.

The doors of knowledge are opened in a hundred directions with fascinating glimpses of what is beyond, and thus we fit him for life, for citizenship, and furnish him really with his birthright.

And then we turn him loose, to win or lose his way, to remove mountains or dig ditches, to sing songs or do deeds worthy of song, to fight battles or to tell of them and draw lessons from them.

The world is his! And he looks around for his tools. Where is now that ease in the command of language—in reading and writing? Where is now that facility with the marvels of number, that skill in the fundamentals of arithmetic so promptly demanded by his employer? Where is now that study of his country's history and institutions so much needed as he faces citizenship?

Where is now that familiarity with mother earth and her broad contours and salient features, that knowledge so much needed in his life among men on earth of the lines and currents of ocean, of the slopes and plains of land, of the lines and currents of life and the heights and levels of life as determined by the surface of the earth?

Rusty is he in them all—and he can't pass an examination for a second grade certificate! Full of wise saws and modern instances, saturated with theories and formulas for explaining scientific phenomena, his head dizzy with dynasties and popular movements, his atmosphere murky with the problem of Dido's sacrifice or Hamlet's insanity, convinced by his own argumentation concerning the destiny of man—he faces the need for readin' and writin' and 'rithmetic, for grammar and spelling and "joggerfy," United States history and drawing—and the good old studies of the seventh and eighth grades.

And in the opinion of the writer *he ought to have them;* he ought to have just had a fresh view of them, a later view, a more mature

view, a study with less of memory and more of thinking through.

All these things in some form belong in the last year or last two years of a high school course and ought to be placed there.

Some of them *are* there. American history is in the last year of every well regulated four year high school, preceded, if the curriculum is properly organized, by two years of European history so studied as to prepare for and explain this re-view (not review but re-view) of America's history, and accompanied by further and matured study of our civil institutions and the individual's relations thereto.

Grammar and reading and composition are there in a well constructed and well balanced course in high school English.

Really in the best and most intelligently conducted high-schools they *are* all there or, without really disturbing any unit already there, they may be placed there and included in the curriculum—all but arithmetic and geography.

And in the humble opinion of the writer these also should be placed there—arithmetic as a half unit and geography as a full unit. The universities are now allowing entrance credit for half a unit of arithmetic properly taught in the third or the fourth year of the high school—and that is the place for it. This is not the occasion for discussing its content or its method, but these should both be determined with reference to the psychology of the seventeen-year-old and the problems so clearly awaiting his use of this later study of the subject.

As for geography, that is surely where it belongs, that is in the twelfth grade, instead of being tucked away as a half unit in the ninth grade. Let the elementary school restore geography—world geography—to its place in the eighth grade. And then in the twelfth grade let it be taught, taught as a science with practical applications. As a science, with library studies of books and current periodicals, and with true laboratory thoroughness in making independent observations, drawing and recording definite conclusions.

"As a science with practical applications"—and what science has so many practical applications and so amazingly varied? Its connection with the whole field of agriculture from drainage to weather, from seed bed to marketing—surely this is self-evident.

With every form and phase of commerce and transportation it is closely linked. The masters of these matters know geography and utilize it.

With history and every utilization of its stores of knowledge —history and ethnology, wars and migrations, political institutions and international prejudices—geography really makes and explains them all.

All civic and social institutions and activities have their roots in and their fruits determined by geography. An Italian, an Egyptian and an English revolution are all vastly different, and geography helps to account for and anticipate those differences.

The political genius, the legislature manipulator and the world statesman—all must know their geography.

The enthusiastic member of the Woman's Club must cram up a little on geography; the athlete who goes for a contest from the Mississippi valley to the Pacific coast must take into account geographical and climatic differences; the aviator literally "goes over the map;" the president of the church missionary society must know something of Laos, or Chosen, or the Congo, or Mesopotamia, or wherever her heart is; the soldier in these larger days must know larger geography than the road to Bull Run or Pittsburgh Landing; he who picks up his daily newspaper must pass an examination on a wide stretch of geographical knowledge or else must "skip it," as other stupids do when he comes to something unfamiliar because of his ignorance of geography.

In short, everybody ought to have and needs to have and must soon have a high school education; and if it is a good one it will include near its close a year of high school geography, of wide scope and studied in its relations to the activities of life.

According to the forthcoming annual report of President Judson, a building which the University of Chicago stands especially in need of is a Research Laboratory for the Department of Chemistry. The present Kent Chemical Laboratory is overcrowded with students. During and since the war the need of developing research in chemistry has become increasingly important. A new building fully equipped for research work and advanced graduate work would leave Kent Chemical Laboratory for the ordinary purposes of the Department. Such a building is estimated to cost about $350,000 and would be erected directly west of Kent Chemical Laboratory.

The former head of the University of Chicago High School, Principal Franklin Winslow Johnson, who resigned to enter war service, has been made headmaster of the Horace Mann School for Boys in New York City. The school is conducted by the trustees of Teachers College, Columbia University. Principal Johnson, who was at the head of the University of Chicago High School for ten years, is the author of a successful book on *The Problems of Boyhood*, published by the University of Chicago Press.

THE USE OF THE ELECTRON IN ELEMENTARY PHYSICS.[1]

By Daniel L. Rich,
University of Michigan, Ann Arbor.

About one hundred years ago there grew in favor the idea that all ponderable matter is made up of bodies called molecules, and that the molecules in turn are combinations of smaller bodies called atoms. These ideas are embodied in what is known as the molecular theory and the atomic theory, theories to be sure, but theories so firmly embedded in scientific thought, so thoroughly entrenched by experimental evidence, that most students of all phases of natural phenomena now look upon atoms and molecules not as hypothetical expedients, but as actual entities having a real physical, objective existence. In fact, a very large percentage of the accepted so-called explanations of scientific phenomena is based upon the assumption of the existence of atoms and molecules, and all elementary textbooks in all branches of science make free use of atoms and molecules with no hesitation whatsoever due to the fear that such things are too difficult for the beginner.

About twenty years ago the electron sprang into the limelight. It has occupied the center of the scientific stage ever since, probably being actively present in about one hundred per cent of the varied phenomena of nature. I take it for granted that we all believe in the existence of the electron just as firmly as we believe in the existence of the atom and of the molecule, and that all present have at least a speaking acquaintance with the electron theory. Yet in spite of this knowledge about the electron and this belief in the electron, I fear a good many have formed the idea that the electron, unlike the molecule and the atom,is a refined minutia to be found mainly in advanced work in electricity, a highly theoretical entity to be studied in the graduate courses of a university, and to be used only by the research worker.

It is perfectly true that the electron is one of the research worker's best friends. Likewise it is true that some very highly theoretical work can be based on the electron; yet I am coming to believe that there is a very large field of usefulness for the electron in the elementary study of physics and chemistry. The advanced theory of electricity is highly mathematical, but the high school boy and girl can learn a lot about electricity without

[1]Read before the Physics Section meeting of the Central Association of Science and Mathematics Teachers at Lake View High School, Chicago, November 29, 1919.

even a knowledge of calculus. It would be foolishness to omit elementary electricity on the ground that an extensive study of electrical theory is beyond the present ability of the high school pupil. Reasoning along the same line, we should not fail to make use of the electron in elementary work simply because some features of the electron theory have to be postponed for more mature minds. Admitting that the electron IS a useful addition to scientific thought, the pupil and the electron should be introduced to each other in high school physics.

The objection that this addition to the subject matter of elementary physics will increase the length of an already badly overcrowded course is an objection worth considering. However, if the introduction, at the very beginning of electricity and magnetism, of the idea of the atomic structure of electricity and the electronic substratum of matter can be made to work a simplification in the treatment, with a resultant increased clearness of presentation and omission of roundabout unsatisfactory explanations that do not explain, and the grouping around a common cause of many apparently diverse phenomena, then the introduction of the electron is justified, and the result can be: fewer pages in the textbook, and clearer pictures in the pupil's mind.

The purpose of my talk is to attempt to convince you, if you do not already agree with me, that the study of electricity should begin with the electron, and that with such beginning a logical development would lessen the difficulties, shorten both the text and the time necessary to start a boy or girl in electricity, and result early in a keener insight into electrical phenomena.

Begin with the idea of the atomic or granular structure of electricity, with the idea that electricity is divisible into particles called electrons. Develop first of all the modernly accepted notion of the neutral atom, an atom not indivisible but made up of separable parts, these parts being a positive nucleus and one or more negative electrons. If some of these negative electrons get lost, the remaining part of such atom is preponderatingly positive, due to the positive nucleus. The other bodies to which the lost electrons have attached themselves exhibit negative electrification, due to the surplus of negative electrons.

In gravitation, experimental evidence causes us to assume the attraction of gravitation, without knowing the cause. With electrons, experimental evidence shows us we need to assume both attraction and repulsion, attraction between negative elec-

tron and positive nucleus, and repulsion between negative electron and negative electron, repulsion between positive nucleus and positive nucleus. Action-at-a-distance theory forms the best avenue of introduction. It is already familiar that the earth pulls on objects; the child does not trouble himself to explain why; it is only the vanguard of research physicists who are exerting themselves over the mechanism and the cause of gravitation; beginners are content with the physical facts, with the knowledge that there is such force, and that this force has been given a name—the force due to gravitation. Likewise, the beginner need not be troubled with the cause or causes of electrostatic fields and electromagnetic fields; simply present the facts that an electron at rest does have around it an electrostatic field, and that an electron in motion does have also an electromagnetic field. Further, just as the beginner is not expected to wrestle with the idea of potential of a gravitational field, likewise the beginner need not be pestered with the abstract notion of potential of an electrostatic field. Masses of gravitational matter, molecules and atoms, attract one another; electrons repel one another. Granted these facts, much can be explained.

The best place to begin perhaps is in electrostatics. When a glass rod is rubbed with silk, tell the student that some negative electrons are transferred from the glass to the silk. This presentation makes plain the following several fundamental ideas: first, electricity is not created nor destroyed; second, some bodies can be given more than their proper share of electrons—when possessing more than their proper share of electrons, these bodies are called negatively charged bodies; third, some bodies may be robbed of part of their electrons—bodies having less than their normal share of electrons are called positively charged bodies; fourth, most bodies left to themselves acquire and keep their proper share of electrons, and are called neutral bodies; fifth, the number of electrons lost by one object must appear on one or more other objects, or as we say positive and negative charges are always numerically equal; sixth, since negative electrons mutually repel, and since positive nuclei also mutually repel, the surplus charges, either positive or negative, in any conductor left to itself must necessarily reside on the outside, to be situated as far apart from one another as possible.

Going back now to the glass rod which has lost some electrons to the silk. The glass rod has a deficiency of electrons. How do we explain charging by contact or by conduction? Suppose this

glass rod be placed in contact with some other object, a metal conductor for example. Some electrons will flow from the metal conductor on to the glass rod, leaving this metal conductor also deficient in electrons, also charged positive. Suppose an object has a surplus of electrons, as is the case with a rod of ebonite when rubbed with flannel. If this ebonite rod with its excess of electrons be placed in contact with some other object, some electrons will flow off on to the other object, giving it also a surplus of electrons, and charging it as we say negative. The same explanation applies exactly to earthing or grounding a body, with the additional idea that the earth is so large and contains so many electrons, that the small numbers we can control when added to the earth or taken from the earth produce a change in the condition of the earth that is entirely negligible, unmeasurable. When a negatively charged body is placed in contact with the earth, electrons flow to the earth. When a positively charged body is placed in contact with the earth, electrons flow from the earth to the body.

The phenomena of electrostatic induction is readily intelligible in terms of the negative electron. Suppose a body negatively charged, that is, one having more than its proper share of electrons, be brought near a neutral body, the negative electrons in the neutral body will be driven to the other side, and that side will become negative. The nearer side now having too few electrons will be positive due to the preponderating influence of the positive nuclei. If the original charged body be positive, i. e., if it has lost some electrons, the electrons in the neutral body will move toward the nearer side. If a body under the influence of a negative charge be earthed, the body will suffer a loss of electrons; if the ground be removed first, and the inducing charge afterwards, the body will then possess too few electrons, and therefore be positive; while if the inducing charge be removed first, and the ground afterwards, enough electrons will flow back into the body to leave it neutral. The explanation of how an electroscope may be charged positively or negatively by contact and positively or negatively by induction offers no added difficulties. The various changes that may be rung on Faraday's ice pail experiment become wonderfully simple in terms of the behavior of the electron. Whether the charged body in the pail be removed first or last or not at all, whether it touch the pail or not, whether the pail be grounded or not—all the student needs to consider is how the negative electrons move.

Now, take up current electricity. Here the historical development of the subject has resulted in an unfortunate state of affairs. By usage the electric current is said to flow from positive to negative, whereas we now all agree that what we call a current of electricity is a real current of free electrons flowing from negative to positive. The customary usage, calling this hypothetical historical current an *electric* current, and the real current an *electron* current, is probably the best way out of the difficulty now; but I see no reason why in another generation or less the term electric current might not have become entirely obsolete and all future literature speak only of the electron current, and give this current its proper sense, for example from zinc to carbon in the external circuit of a Leclanche cell.

Now, what makes these free negative electrons move along a conductor? We often speak of the analogy between water pressure and electric pressure, and usually apologize for the crudeness of the analogy. But is there any necessity for the apology? If gravitational mass and electromagnetic mass should turn out to be one and the same thing, would not a slight change in our systems of units result in there being perhaps not an identity but at any rate a very close relationship between mechanical pressure and electric pressure? And may not the term electric pressure without modification or apology come to be the better expression to use? The ordinary high school pupil has no idea whatsoever concerning gravitational potential, but he does have a clear notion of what altitude means, and of differences in level. Similarly, the ordinary high school pupil at best has only a very hazy notion of electric potential. Would it not be well in high school physics to omit electric potential altogether, and teach him simply in terms of electric pressure and differences in pressure? The student may not know why water runs down hill, but he knows which way it goes, and how to make it go. So, electrically, may not the beginner grasp the idea of which way free electrons flow, and how to make them move, without being troubled with the abstract idea of potential, and without even thinking of work per unit quantity, or of $M^{\frac{1}{2}}L^{\frac{1}{2}}T^{-1}c^{-\frac{1}{2}}$?

At any rate, the idea that a current of electricity is an actual current of free electrons is an idea easy to grasp. It makes easy a clear mental picture of the difference between conductors and nonconductors and of the various grades of conductivity. It suggests more intimate relationship between resistance and friction, and makes plausible the fact that the Joulean heat losses

are proportional to the square of the current, i. e., proportional to the square of the velocity of the moving electrons.

The assumption of the electromagnetic field around a moving electron immediately connects magnetic and electromagnetic phenomena; and this assumption coupled with the modern view of the structure of an atom, pictures clearly how a piece of iron is magnetized by bringing the orbits of the electrons into parallel planes.

My talk would be too long if I attempted to discuss the possibilities of the electron in elementary chemistry. Suffice it to say that there is now recognized an intimate connection between valence, chemical affinity, and the number of electrons in the outer regions of the atom. Ions and ionization, dissociation, all electrochemical reactions of various kinds—a vast field and a whole host of phenomena pay homage to the little electron.

The electron is not an ultimate explanation, but it is a satisfying reason why. Its use does result in the unification of the underlying phenomena of nature, of magnetism and electricity, of light and heat, of the radiation and the absorption of energy, of the constitution of matter, of the affinities and the decay and the transmutation of the elements.

It is the biggest little thing that has entered science in historic time, and it should not be relegated to the graduate courses of a university where only one in ten thousand has a chance to hear about it. Put it into the elementary textbook, and strike out the antiquated theories to which it is infinitely superior. Don't tell a class of beginners that electricity is a hypothetical substance which exhibits attraction and repulsion at a distance and shows no orientation; nor that an electric charge is the manifestation of a discontinuity of an ether strain tube. Such metaphysical abstractions to a class that finds even arithmetical subtraction difficult is the height of pedagogical folly.

Better, tell the beginner that electricity is made up of electrons, whose nature is as yet unknown, but in terms of whose behavior a very large percentage of natural phenomena may be explained and understood. The electron won't explain everything, but the difficulties it presents are not so numerous as those presented by older theories; and when it can be used it results in an explanation readily plausible and intelligible to even a beginner.

PRELIMINARY INTELLIGENCE TESTING IN THE DEPARTMENT OF PHYSICS, UNIVERSITY OF CHICAGO.[1]

By Harvey B. Lemon,

If one is to regard a general course in physics as coming under the head of intelligence testing, the title of this paper will fairly well fit the subject matter. If, however, by intelligence testing we mean preliminary examination of a student with reference to his degree of fitness for his subject, our title, which was somewhat hastily chosen owing to the necessity of getting the program into print, applies to only a relatively small part of our remarks.

Preliminary intelligence testing in physics at the University of Chicago is merely one feature of the general reorganization which our college courses have been undergoing during the last five years under the immediate supervision of the writer. This reorganization has been necessary because of changing conditions in these strenuous years of flux. Two of the most important of these changing conditions have been the notable development of the applications of physics in industries during the last decade, recognition of which has been tremendously emphasized by the war; and, second, although not independent of the first, a very notable increase in the number of students. Ten years ago this department was running an average of twelve junior college sections, registering an enrollment of 250 students per year. During the present year we have estimated in eight junior college courses, 36 sections and a total of 820 students. Of these 36 sections, 28 are college courses. It is noteworthy that the decrease of registration in the University caused by the war the last two years has not been duplicated in physics and chemistry.

The distinction firmly insisted upon by the University of Chicago between college instruction and preparatory instruction in physics is identical with the distinction between the analytical method of treatment and the descriptive. We hold that no college course which is not analytical is a college course in the sense in which we use the term. We insist that in the vast majority of cases an analytical course cannot be carried successfully by a student who has not had descriptive courses in the subject matter beforehand. For this reason, claims for advanced standing brought from other institutions to us are frequently refused or at least granted only in part when it appears that these college courses have admitted students who have not had high school

[1]Read before the Physics Section, Central Association of Science and Mathematics Teachers at Lake View High School, Chicago, November 28, 1919.

physics. We recognize perfectly well that the claim made by some college teachers that they cannot distinguish in their classes people who have had high school physics from those who have not, may be frequently justifiable. Nevertheless any college course which does not presuppose the descriptive work cannot be a strictly analytical course and cannot therefore be equivalent to the college courses of this University.

Our reorganized plan of college instruction appears to best advantage in those courses catalogued as Physics 3, 4, and 5, which constitute the year's sequence given in the fall, winter, and spring quarters, respectively. These courses meet nine hours a week and are expected to consume a total of fifteen hours a week of the average student's time, if time spent on preparation is included. Of the nine hours under definite instruction, one hour is devoted to a demonstration lecture attended by all sections together. Eight hours are devoted to classroom and laboratory exercises with practically an equal division of time between actual experimental work and informal classroom discussion.

The advantage of having a laboratory in which a class can draw up their chairs in front of the blackboard informally for common discussion of questions at any time has been pointed out with considerable emphasis before this association in times past. We consider it one of the vital features of successful teaching. With regard to the demonstration lecture, it has been adopted to a limited extent with a threefold purpose in mind.

First, if the senior men of the department are associated with elementary instruction at all, it is only in the demonstration work that this association can be made. Our elementary classes have an opportunity to become acquainted with Professor Michelson when he lectures on such subjects as the rigidity of the earth, interference of light, measurements of the velocity of light, or on problems in spectroscopy. They become acquainted with Professor Millikan in his lectures on the kinetic and the electron theory. In the course of a year they thus become acquainted with all members of the staff in connection with those phases of modern physics wherein these men have research reputations.

In the second place, there are a great many important applications of physics in modern civilization with respect to which the textbooks are never up-to-date. We have demonstration lectures on the fundamental mechanical principles of flight, on fluid motion, on the gyroscope, on the boomerang, on low temperature phenomena, on change of state, on Brownian motions, on

the periodic relations between the elements as brought out in the study of X-rays, on the measurements of "e," on the structure of atoms, on electrical oscillations, on harmonic analysis of sound, on water waves, on applications of spectra to the problems of the stellar universe, as well as to the structure of the atom, on X-ray spectroscopy, on interference and diffraction.

The lectures on these subjects are real demonstration lectures in which upwards of three hundred different experiments are performed before the class. Very careful study has been made to enable the presentation of this material divorced from mathematical complexity. Even such phenomena as the gyroscope and the boomerang have been successfully attacked with no more mathematical machinery than that involved in a vector addition diagram. While some of the apparatus involved is elaborate and costly, by far the major portion of it is simple and obvious.

In the third place, while students are expected to understand and are examined on the material presented in demonstration lectures, these lectures are nevertheless conducted with a view toward general relaxation and relief from the strenuous grind of laboratory routine measurements and computations, and if students' comments are to be taken as any indication, the demonstration hour each week is the most enjoyable of the course.

For the benefit of teachers and advanced students, this demonstration material has been collected into a special single course offered as Physics 7 in the University College during the year and given usually under the same notation as a teachers' course in the summer quarter. When so organized, much more emphasis is laid upon the analytical aspect of the work and the course thus carries senior college or graduate credit.

In the laboratory continual effort is also being made toward modernization of the classical material. The efficiency of the 4-cylinder, 4-cycle gas engine is regarded as a more desirable experiment than one on the efficiency of the water motor. The graphical analysis of the tensions and compressions in a simple bridge of which the model is before the class is thought to be of more value than routine problems assigned on the basis of geometrical figures representing tensions.

We regard it as highly important that the same man be in charge of both laboratory and recitation work, but in view of the large number of sections involved in these courses in each one of which the instructor has full responsibility over classroom and laboratory work, careful coordination must be made. It is im-

portant on the other hand that independence in the presentation and entire freedom in teaching be in no way sacrificed. Consequently the general physics course can be accurately described as being given by a committee composed of all of the instructors. The instructors and their assistants meet at frequent intervals to discuss the technique of experiments, problems, text and examination questions, and individual student cases. The final examination is worked out for the entire course by this committee of the whole. The classes are informed of the method used, which promptly establishes a cordial relation between the instructor and his individual group. Student and teacher are cooperating with the ultimate aim of passing the course, the standard of which is fixed on an entirely impersonal basis; even the marking system is not arbitrary but grades are referred to the average of the classes, a procedure perfectly legitimate when numbers of students mounting into the hundreds are involved.

Finally, great care is used in admission and early examination of students in these courses with a view toward discovering their individual lack, either of preparation or of ability and it is here that we come to the subject announced in our title—the question of preliminary intelligence testing.

At the first meeting of all University classes in physics the following data are secured upon a form card from every registrant in each class: Name; age; classification in University, that is to say, A.B., S.B., Ph.B., J.D., M.D., etc.; year in University; high school physics taken, when, where, and with what textbook; previous mathematics courses in high school, in college; previous science courses in high school, in college; other courses taken simultaneously with the present course in physics; why is the student now registered for this particular course in physics. These cards, upon which is entered in due course of time the student's academic history in physics, go into a permanent departmental file and are available for future reference.

At this first session an efficiency test is also given. Questions are dictated and answers are to be written down at once, although sufficient time is allowed on each question to enable the student to put it down on a pad of paper if he so desires. Students are assured, however, that the questions are of such nature that it should not be necessary for them to have to "stop and think" for any extended period. These questions cover high school physics and some arithmetic and algebra. For example:[1]

[1] Some of these questions are taken from that excellent little book, "An Introduction To Laboratory Physics."—*Tuttle*.

How much current does a 50-watt lamp consume on a 100-volt circuit?
What is Boyle's law?
How many degrees below zero is absolute zero, and why this number?
What is the difference between yellow and green light?
$(m+x)\ (m-x) = ?$
Reciprocal of 2/7 = ?
Solve: $3 : 12 :: 16 : x$
Reduce: $\left\{\begin{array}{l} .395 \\ .005 \end{array}\right.$ to percentage
Simplify: $a^5 \times a^3$, $a^{2\times 5}$, a^{4+2}
If pv is the constant, how is p affected by doubling v?
Equation $y = ax - b$; solve for x. What is y equal to when $x = 0$?

The results of these questions are entered on the students' record cards and carefully studied before the second class meeting. Students who show averages below 50 per cent have their records carefully scrutinized and are then interviewed. Many of these are clearly out of place and change their registration at once without any further pressure being brought to bear. Others make protest and are always allowed to act in accordance with their own wishes, particularly when they feel that the result of the test is not an accurate indication of their potential capacity for the work.

Some statistics of this year's classes may be not without interest: of 171 registrants, 40 were below 50 per cent and were interviewed; 22 cordially agreed that they were not prepared for college physics and dropped out at once with a loss of but one hour's time in entering another class. Many of these requested advice as to what they should take and acted directly in accordance with it, some going back into preparatory physics, others taking elementary courses in mathematics, some going into chemistry. The remaining 18 students were all warned as to the importance of carefully scrutinizing their reactions in the first few weeks and advised to make special effort. Of these 18, 9 stayed by the work and are now ultimately making good; 9 others dropped within four weeks because of obvious failure to continue with a passing grade. In the last four weeks several other students have dropped, but these cases have almost without exception been due to conditions arising late in the quarter, mostly because of illness, a condition which has interfered with the rest of their University work as well as with their physics.

We find without exception that some of the greatest deficiencies of our students are connected with ideas of mass and weight, and with the definitions of velocity work and power, all of which they should have learned in high school. After three weeks in their college course this fall in which there had been ample review of these notions, the following questions were given:

What is the difference between mass and weight?

Define velocity, acceleration, work, power. Answers were graded:
A. Unquestionably correct.
B. Nothing incorrect, but incomplete.
C. Partly right and partly wrong.
D. Entirely wrong.

Out of 425 answers 180 were A or 42 per cent; 112 were B or 26 per cent; 83 were C or 20 per cent; 50 were D or 12 per cent. With respect to the definition of velocity, however, there were only 18 out of 85, or 21 per cent who included the idea of direction in their definition, and these came almost entirely in one section taught by a British trained man who had laid especial stress on the matter. Apparently our students came from high school courses, this year at any rate, entirely innocent of any vector notions or of any distinction between velocity and speed.

It is far too early to attempt any analysis of the situation with respect to our incoming students with reference to the schools from which they come, but we feel that we will soon be in possession of valuable data in this direction. This year we have, out of a total of 171 registrants, 90 from out-of-town high schools and 81 from the high schools of Chicago or its suburbs. Of the out-of-town students, 22 per cent have been doing unsatisfactory work, C— or below, not necessarily failing in all cases, however, and of the city students, 28 per cent fall in the same category. It is too soon, however, to generalize from these results. It is obvious that our records can be analyzed with respect to any individual school as soon as we have a little more time to gather statistical material. We urgently desire to get the cooperation of the high school people, particularly around Chicago, in studying this data, which will, of course, be freely taken up with the instructional staff of any particular school in so far as it relates to that school. It has invariably happened during the writer's experience of the last four years as departmental examiner that cooperation between the University and a high school based upon a mutual discussion of the teaching problems involved in both institutions has resulted in recommendations through the Examiner's Office, the adoption of which has rendered material improvement in the working conditions in the high school and in the equipment of the students which were there being prepared.

In closing, it is needless to emphasize that we do not expect by merely gathering data to solve the great problems of teaching. Anything which pretends to do so can be safely set down as a nostrum and consigned to oblivion. The problems of teaching will differ from generation to generation as human nature shows individual variation.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS ANNUAL BUSINESS MEETING, NOVEMBER 29, 1919.

The annual business meeting of the Central Association of Science and Mathematics Teachers was held at the Lake View High School, Chicago, Saturday morning, November 29, 1919. President Isenbarger presided.

The minutes of the business meeting of November 30, 1919 were read and approved.

The following report was read by Mr. H. R. Smith for the Committee on Resolutions. The report was accepted:

1. Resolved: That the Central Association of Science and Mathematics Teachers expresses its thanks and appreciation to the Chicago Board of Education for granting the use of the Lake View High School for the 1919 meeting; and to Assistant Superintendent James E. Armstrong for cordial assistance upon the general program.

2. Resolved: That the principal, teachers, and musical organizations of the Lake View High School be voted the sincere and hearty thanks of the Central Association for their generous and hospitable entertainment during our present meeting.

3. Resolved: That formal and special recognition be given to the efficient service rendered by our retiring treasurer, John B. McClellan, during the past four years. His faithful and untiring efforts have contributed much to the position maintained by the Central Association during the period of the war.

4. Resolved: That the Central Association formally express its appreciation of the work of Mrs. Anna Y. Reed in vocational guidance and for her interest in coming from Washington, D. C., to present her theme upon our program.

5. Resolved: That our hearty thanks and appreciation be voted to President Lynn Harold Hough and to Professor Robert A. Millikan for their addresses upon our general program.

6. Resolved: That to the end that schools may be kept open and competent teachers provided, we declare it to be the patriotic duty of taxpayers and lawmakers to provide sufficient revenues to insure a living wage and a saving wage to the teacher of the elementary school and high school.

7. Resolved: That the members of the Central Association of Science and Mathematics Teachers declare the urgent necessity of a Department of Education with a cabinet officer at its head to the end that illiteracy be overcome and education be made more efficient throughout our land.

8. Resolved: That in the constitutional convention of Illinois or of other States, articles in the State Constitution relating to schools be made brief comprehensive statements of principles, rather than detailed regulations of particular conditions.

Willis E. Tower, Chairman.

The following report of the Committee on Nominations was read by the chairman, Mr. Harry D. Abells: President, J. Albert Foberg, Crane Technical High School, Chicago, Illinois; Vice President, Frederick R. Gorton, State Normal College, Ypsilanti, Michigan; Treasurer, Lewis L. Hall, Morgan Park High School, Chicago, Illinois; Corresponding Secretary, Ally L. Marlatt, University of Wisconsin, Madison, Wisconsin; Assistant Treasurer, E. S. Tillman, High School, Hammond, Indiana.

The present secretary was elected last year for a two-year term.

By vote of the Association, the Secretary was instructed to cast the white ballot for these nominees and to declare them elected.

The following report of the Committee on Necrology was read by Mr. C. H. Smith:

During the past year reports have been received of the death of two of our members.

Miss Celestine Rice was a member of the Biology Section of the Association from 1908 until the time of her death. She was a teacher of science in the high school at Decatur, Illinois, for eight years and later teacher of science and dramatics in the high school at Lincoln, Nebraska. Her record as a teacher in both positions was an enviable one. To quote from a letter from her superintendent at Lincoln: "Miss Rice was a very unusual woman and a very exceptional teacher, the best high school teacher of biology I have ever known. She was not only exceptionally good in the class room but a powerful factor for right things in the general life of the school. She was a pioneer in the dramatics of the Lincoln High School, but won her way rapidly and created a demand, both from student body and faculty, for the best."

James E. Weyant, long a member of the Central Association of Science and Mathematics Teachers, died on May 25, 1919. Mr. Weyant was born in Elbridge, Michigan, on the 25th of July, 1874. His bachelor's degree was obtained at Albion College, and his master's degree at the University of Michigan. For the past ten years Mr. Weyant was in charge of the physics department of the Shortridge High School, Indianapolis.

The report of the Committee on Advertising follows:

The work of the committee began early in April, at which time letters were sent to the fifty advertisers who had used space in the 1918 booklet, asking for renewals of their contracts. At about the same time, twenty-five additional letters were sent soliciting advertisements from other firms. By the middle of June signed contracts of renewals had been received from about two-thirds of the old advertisers. Further correspondence during the summer and early autumn resulted in securing renewals from most of those who had not responded to the first letter. Several of our former advertisers at first declined to renew, but after writing them again, or, in a few cases, after a personal interview, they agreed to take space. Only two of last year's advertisers failed to renew. From time to time, during the summer, letters were sent out to advertising prospects in an effort to add to our list, and in some cases personal calls were made. The net result of these efforts was eight new advertisers making a total for this year of fifty-six.

The value of our booklet as an advertising medium is illustrated by the fact that one of our advertisers increased his space from half a page last year to a full page this year, while another increased from one page to four pages. One of our new advertisers is using three full pages.

The total amount of space contracted for was fifty-three pages the income from which is $548. George Sype, Chairman.

After showing by applause its appreciation of the committee's good work, the report was accepted.

Following is the report of the Membership Committee:

The methods followed by the committee this year have been substantially the same as those used last year.

A brief article, "How It Grips," was printed in connection with an application blank and sent by the Treasurer to each delinquent.

A letter dated September 15 was sent to about 2500 teachers, chiefly in the neighboring states. These letters were printed on the letter head of the Association and enclosed in a one-cent envelope, which also bore the name of the Association.

Early in October a letter was addressed to a member of the Association in each of the high schools in and near Chicago asking that person to assume the responsibility of collecting dues from present members and to enroll new members.

A letter addressed to members was printed in SCHOOL SCIENCE AND MATHEMATICS for October urging their cooperation in securing new members.

Footnotes for the different pages of the program were also prepared.

In addition to the work done by the members of the committee, the President of the Association wrote a follow-up letter to representatives of the Association in the diffierent schools, had an appeal made to each Mathematics and Science section of the all-day meeting in Chicago, November 14, and had the interests of the Association presented at the sections of the University of Illinois Conference, November 21.

Following the usual custom, copies of the program were sent to those on the list prepared by the committee. Copies were also sent to the teachers of science who attended the conference at the University of Chicago last spring.

Charles S. Winslow, Chairman.

REPORT OF THE COMMITTEE ON RAILROAD AND STEAMSHIP MAPS.

Your committee chairman sent a letter to Director General Hines making general protest against the quality of railroad maps used in folders and advertising in general, asking him if anything could be done to improve the quality of such maps and suggesting the preparation of a rather large scale map which could be put out in pocket atlas form for use by teachers and travelers in general. This letter was referred to the Assistant Director, Garret Fort, from whose reply the following extracts are taken:

"By the usual railroad map I assume you mean the one in the time table folders. Such maps are not presumed to be accurate maps from a geographical standpoint and not intended to convey the information mentioned in the fourth paragraph of your letter. For many reasons it would be obviously impossible to have such a map in the ordinary time table folder. As to a detailed map of the U. S. A. showing all transportation lines, contour lines, drainage, and other information as suggested by you, I cannot see the obligation of the railroads to furnish such a map. If there is a commerical demand for them, I have no doubt that any of the large map publishers would be glad to give consideration to your suggestion."

The pocket atlas suggested is an idea which your Chairman has long had in mind and he has put it up a couple of times to one of the map publishing houses. He will try again. In his own traveling experience he sees the need of it constantly. What we need is a very accurate map which will show the true positions of all railroads and a plentiful detail of towns, and he should like to see it made with contours to bring out the highlands and lowlands; with the map printed in colors to the contours. Such an atlas would be about four inches by ten, opening out to a double page of about eight by ten, and the country would be covered by thirty or forty rectangles of this size.

This would make it possible for the traveler to have the detailed map in his pocket or in his bag, which would give him all of the railroads to a given town and a great deal of information which he wants and is not now able to get short of the library.

The committee desires to submit this report with the request that the committee be dismissed since it seems that there is nothing further for it to do.

J. PAUL GOODE,
Chairman.

Mr. John H. McClellan read the report of the treasurer. It showed receipts for the year of $2,676.02, expenditures of $2254.49, and a balance on November 28, 1919, of $421.53. The net constitutional membership on November 28, 1919, was 1077, and the paid-up membership on the same date, 977. He spoke of the duty of each member to secure others and enlarged on the benefits covered by the $2.50 fee.

It was voted to accept the report.

Mr. M. J. Newell reported that the Auditing Committee had found the Treasurer's books and statements correct.

Mr. McClellan asked for an official audit at the time he turns his books over to the newly elected Treasurer. It was voted that the Treasurer close his books on January 1, 1920; that an audit be made at that time by a committee to be appointed by the President; and that a report of Treasurer and Auditing Committee be made to the Executive Committee at its January meeting.

Two proposed amendments to the constitution were presented for consideration.

The first was presented by the Earth Science Section in accordance with instructions voted by its members on November 29, 1918. It had been sent to SCHOOL SCIENCE AND MATHEMATICS for publication in accordance with constitutional requirement, but had been missent and so was not printed. The president stated that on the advice of the executive committee he would rule that announcement of intention to present the amendment having been made at the general meeting of November 28, 1919, the constitutional requirement to publish had been met and so action might be taken.

"It is proposed by the Earth Science Section to amend Article 4 of the constitution by substituting the term 'geography' for 'earth science.' As amended, the article will read:

"This Association shall be divided into sections as follows: Biology, Chemistry, General Science, Geography, Home Economics, Mathematics and Astronomy, and Physics. Each section shall be composed of the members of the Association who are especially interested in the subject represented by the section. At the time of making application for membership, a candidate should indicate the section or sections of which he wishes to be a member."

It was moved, seconded, and carried that Article 4 be so amended.

In accordance with constitutional requirement, the following notice of proposal to amend Article 5 was published in the November, 1919, number of SCHOOL SCIENCE AND MATHEMATICS.

"Last year it was voted to suspend publication of the proceedings in the hope that an increase of dues would not be necessary, but in spite of this economy, the Association finds that it must have more income or further decrease the quality and the amount of its service to its membership. It is for the purpose of avoiding such a calamity that a committee appointed from the Executive Committee, after thorough investigation, makes the following recommendation for an amendment to the constitution, to go into effect December 1, 1919.

"Resolved that Article 5 be amended to read as follows:

"The annual dues of active and associate members shall be three dollars ($3.00), payable at the annual meeting for the following year. Members in arrears for one year shall be dropped from the list of membership."

After Mr. McClellan explained why rising costs of everything being bought by the Association made such an increase of dues necessary, it was voted to adopt the amendment.

It was then voted that the new amendment regarding dues go into

effect January 1, 1920, and that members in arrears be served notice that $2.50 will be accepted in payment of dues until that time.

The meeting then adjourned. HARRY O. GILLET,
Secretary.

TREASURER'S REPORT, NOVEMBER 28, 1919.

RECEIPTS.

Balance at report, November 29, 1918		$ 451.87
Refund Earth Science Section expense		2.00
Advertisements in 1918 programs		356.00
Advertisements in 1919 program		40.00
Membership dues at $2.50	$1,777.50	
Membership dues, irregular	48.65	
Total Membership dues		1,826.15
Total receipts		$2,676.02

EXPENDITURES.

Subscriptions to SCHOOL SCIENCE AND MATHEMATICS		$1,227.05
Subscriptions to American Journal of Home Economics		78.00
Programs 1918, printing and distributing		431.63
Biology Section, expense	$ 7.50	
Earth Science Section, expense	12.00	
General Science Section, expense	27.32	
Home Economics Section, expense	2.00	
Executive Committee, expense	3.00	
Mathematics Section, expense	10.83	
Physics Section, expense	3.50	
Badges 1918	15.50	
Badges 1919	20.10	
Convention speakers, 1918	40.00	
President's expense	5.60	
Membership Committee, expense	83.00	
Secretary's expense	9.01	
Treasurer's postage	55.00	
Treasurer's clerical expense, 1917-1918	50.00	
Treasurer's clerical expense, 1918-1919	50.00	
Treasurer's bond, 1918-1919	2.50	
Advertising Committee, expense 1918	12.95	
Printing and stationery, 1919	101.50	
Refund to advertiser	6.00	
Refund to member	.50	517.81
Balance, November 28, 1919		421.53
		$2,676.02

MEMBERSHIP REPORT FOR THE YEAR ENDING NOVEMBER 28, 1919.

Paid-up membership, November 29, 1918	977
Honorary membership	9
Total membership	986
Delinquent, but left on list as per constitution	170
Total names remaining on list, November 28, 1919	1,156
New names added during the year	156
Total	1,312

Resigned during the year	61	
Deceased or dropped for delinquency	174	235
Net constitutional membership November 28, 1919		1,077
Paid-up membership, November 28, 1919		907

JOHN H. MCCLELLAN,
Treasurer.

REPORT ON EXCURSIONS.

EXCURSION TO LINCOLN PARK.

The party from the Biology Section, all out-of-town teachers, went on the excursion. We went first to the Academy of Science. Here we examined the mushroom exhibit, then the many other exhibits of the building. We last entered the celestial sphere at the top of the academy and viewed the starry groups. Several times out-of-town teachers remarked: "I am so glad I came."

On our way from here to the flower conservatory we passed through three of the animal houses and the bird house, and last of all visited the conservatory. Out-of-town teachers think we have a great advantage in having access to such places. Probably we should use them to an even greater extent than we do. V. O. GRAHAM,

Instructor in Botany, Lake View High School.

A TRIP TO THE PLANT OF THE LINDSAY LIGHT CO.

A party of the members of the Chemistry Section of the Central Association of Science and Mathematics Teachers spent a very interesting afternoon, November 29, inspecting the plant and chemical products of the Lindsay Light Co., at 161 E. Grand Ave., Chicago, Ill., manufacturers of gas mantels.

These mantels consist essentially of a woven mantel on which is deposited 99 parts of Thorium nitrate and 1 part of Cerium nitrate, which burns to the oxides of these metals. As a result of the war, their supply of Thorium nitrate was stopped so that they were face to face with the alternative of developing a process of making Thorium nitrate from the ore, or of going out of business. With true American resourcefulness, they tackled the job, making as small expenditures as possible and increasing the equipment as new details were worked out. Naturally the plant seems crude and unattractive in appearance, but the main thing is that they were very successful, so that only fifty per cent of the Thorium nitrate made by them is necessary for their own mantels, and the remainder, together with many other rare metal products, are disposed of to other manufacturers.

The details of the processes in the plant, together with the chemistry involved, was ably and interestingly told by Mr. Brendt of the Lindsay Light Co. The process, like that of our new dye industry, represents one of many manufacturing processes which because of the war, the American people found it necessary to work out, and thus prove that we can be independent of foreign manufacturer. Many of these processes will become permanent additions to American industry, and thus they form a silver lining to the terrible war cloud. G. P. DRUECK, JR.,

Dept. of Chemistry, Nicholas Senn High School, Chicago, Ill.

EXCURSION TO THE UNDERWRITERS LABORATORIES.

Although the Physics Section of the Central Association of Science and Mathematics Teachers had an all day meeting with the American Physical Society in the Ryerson Laboratories, University of Chicago, a number of the physics teachers left this meeting to join a party of the General Science Section and others, Saturday afternoon, November 29, at the Underwriters Laboratories, 207 E. Ohio St.

The party was first assembled in an elegant reception room, and truly elegant in its decoration and furnishings, in spite of the fact that it was of fireproof construction. Here a brief history of the institution and the character of its work was given by Vice-President Small. As the party numbered over forty, it was divided into three groups, and each group was assigned a guide who explained in detail the work in each department of the institution, as the groups were taken from room to room.

This excursion can be arranged each year with value to the Association, if the matter is taken up early with Mr. Small.

JOHN K. SKINNER,
Physics and Mathematics, Senn High School, Chicago, Ill.

REPORT OF MEETING OF BIOLOGY SECTION.

FRIDAY, NOVEMBER 28.

At the opening of the meeting a suggestion was made by the chairman, Mr. C. L. Holtzman that Miss Emma Francis of the Battle Creek, Mich., Sanitarium be invited to come over from the Home Economics Section on Saturday morning and give her exhibit of rats fed different experimental diets. This was assented to unanimously.

The chairman then announced the Committee on Nomination of Officers: Chairman, Fred T. Ulrich, Plattville, Wis.; C. P. Shideler, Joliet, Ill.; Helen Southgate, Michigan City, Ind.

Dr. A. S. Pearse, of the University of Wisconsin then gave his illustrated lecture on "Tropical Nature." This lecture was of great interest to the members of the section, as it was illustrated by lantern slides made from pictures obtained by Dr. Pearse in an extensive study of both plant and animal life in Hawaii, the Philippine Islands, and tropical South America. Among the many studies of life made in the tropics and illustrated by slides the following were of absorbing interest:

The Fiddler Crabs—their burrowing habits, mating, fighting of males, the peculiar Ghost Crab.

The tropical rain forest of South America, with its coffee plantations on the uplands, the bananas of the lowlands, the strangling tree (Clusia), the Bromelias among plant life and from animal life were shown such as the deadly bushmaster, the great centipedes and millipedes, the tauran-tulas, giant land snails, the peculiar snap dragon toad, foraging ants, the ants also which live in the acacias and both bite and sting, leaf-cutting ants, which build galleries that sometimes extend 1500 feet underground.

Views from the swamp life of these forest regions were shown, with their mangroves and alligators.

Then in contrast to the foregoing were many slides exhibiting the life of the mountain streams of the high Sierras with their curious catfishes and mud-eating fishes.

Lastly were shown pictures taken by Dr. Pearse of the desert life of the South American tropics with giant cacti from thirty to forty feet in height, snails which aestivate, harvester ants, which store grain under ground, desert hermit crabs and desert terrapin

Next was read a paper by Dr. Wm. Crocker, University of Chicago, on "Gypsum as a Fertilizer." As this paper will be published in SCHOOL SCIENCE AND MATHEMATICS," no comment need be made upon it in this report. No brief comment could do justice to the paper.

Miss Elizabeth Foss of North High School, Minneapolis, read a paper on "Greenhouse Laboratories in the Minneapolis Schools." This brought out many questions which showed the interest in the tendency just now toward the greenhouse as a valuable adjunct to the biology laboratory. This paper will also be published so that further comment is unnecessary.

The Friday session of the section closed with a report made by Harold B. Shinn, of the Shurz High School, Chicago, on the progress made by the reorganization committee upon the subject "Our Aims in Biology and the Measurement of Results."

This report showed the result of a questionnaire sent out to teachers by the committee in order to determine the opinion of citizens other than teachers" as to what the aim in biology teaching should be. It was found that only a fraction of those to whom the questionnaire had been addressed responded; but the results had been tabulated by Mr. Shinn so as to show an interesting situation.

The tabulation was put under two heads, viz, (1) The Aim in Biology Teaching, (2) What Shall be Taught? Under the first head the result showed that public opinion gave "ability" the most important place with "appreciation" coming second. Under the head of "What Shall Be Taught?" the results were very much less definite.

Considerable discussion followed the report. Dr. Eliot R. Downing, another member of the committee made further explanations and showed the difficulties encountered by the reorganization committee on account of the small number of responses, there being only about fifteen per cent of the total to whom the questionnaires were sent.

This committee is to be continued another year and it is hoped that greater cooperation of the teachers may be secured.

SATURDAY, NOVEMBER 29.

Miss Emma Francis of the Battle Creek, Mich., Sanitarium came over from the Home Economics Section and gave a very interesting and instructive talk on her exhibit of rats fed on experimental diets.

Following this the committee on nomination of officers for 1920 reported the following who were unanimously elected: Chairman, Grace J. Baird, Bowen High School, Chicago; Vice-Chairman, C. P. Shideler, Joliet Township High School; Secretary, Elizabeth Foss, North High School, Minneapolis, Minn.

The first of the two remaining topics to be taken up was "The Boys' and Girls' Club Movement." Mr. O. H. Benson, of the States Relation Service, United States Department of Argiculture, was on the program for an address upon this topic, but was unable to be present. His place was taken by Mr. T J. Newbill, sales manager for the Burpee Can Sealer Co. Mr. Newbill was until recently assistant to Mr. Benson in the States Relation Service. He presented this important question in a clear, concise manner. The guiding thought of the movement is "Ownership as an incentive to stimulate the boys and girls to work along the right lines," as was shown by the speaker.

A few of the more conspicuous thoughts developed in the address were as follows:

"The present system of education is appealing more to boys and girls than the fairy tales of the nursery."

"Socialization" the great need in the country districts.

"Homelife" the biggest thing in education.

The great importance of a sense of "management" in the education of boys and girls.

We hope to have this address published in full in SCHOOL SCIENCE AND MATHEMATICS.

"Home—School Projects in Cook County, Ill." was the last subject of the program and was handled by Mr. Edwin J. Tobin, County Superintendent of Schools of Cook County. The speaker knew his subject thoroughly and knew how to present it. Furthermore, it came with authority. Superintendent Tobin is an enthusiast with regard to this move-

ment, and has the inspiration which is born of enthusiasm The results achieved in the Cook County schools speak for themselves.

Some of the more important points brought out in this address were as follows:

In the past the school system has not been organized to teach childred to do things.

Home-school projects can be done in the school only to a limited extent. They must be carried out largely in the home.

The school system should see to it that the home-school projects are carried out in the home.

The power of the school system alone can make this work succeed.

The speaker by no means confined himself to generalization, but went into details in the discussion. He said that in Cook County when a child reaches the fifth grade, he must undertake a home-school project. That from ten to fifteen per cent is added to his academic grade if the project is carried through satisfactorily, and that "achievement credit" is given to stimulate the work. Graduating exercises are held when achievement credits and emblems are awarded.

Much of the matter presented by Superintendent Tobin was a revelation to members of the section.

Adjournment.

MINUTES OF THE CHEMISTRY SECTION.

FRIDAY AFTERNOON, NOVEMBER 28.

About forty-five were present when the meeting was called to order by the chairman, Mr. S. R. Wilson. The committee on reorganization appointed at the 1918 meeting was responsible for the program of this meeting, reporting on the work it had done, its findings, and its plans for the future. The work of the committee in studying "Fundamentals in Subject Matter" was presented by Mr. R. W. Osborne, Francis W. Parker School, Chicago:

I. FUNDAMENTALS IN CHEMISTRY.

Reorganization, if it is to be successful, must be based upon a clear understanding of two things: first, the reasons, failures, shortcomings which make reorganization necessary; and second, the purposes and aims which are to be attained as a result of the work.

Your committee, therefore, as its first task undertook to redefine the purposes and aims of our chemistry teaching, to formulate the objectives (to use a more recent term) which we want our classes to reach as a result of their study of chemistry. Instead of attempting to evaluate these objectives relative to one another it seemed wisest to the committee to arrange them in their psychological order, that is in the order in which the pupil should become conscious of them. The results of this work were embodied in the first section of the questionnaire which, I am sure, has been received by most of those present. Additional copies have been prepared and are available for getting before you more quickly the report of the committee. These objectives, restating them more briefly, are:

1. Supplying motive to the pupil through his conception of the value of the work to himself and the opportunities for achievement which it offers.

2. The understanding of, and the ability to use the scientific method of procedure as a means of solving his problems.

3. Acquisition of knowledge as a basis of skill.

4. Appreciation, which means the comprehension and understanding of the phenomena of life.

5. Ethical and moral values through conceptions of the universe as governed by law unchanging and ever operative.

Forty-two replies to this statement of aims showed thirty-seven in entire agreement and five with only slight modifications. With this agreement on aims the committee next attempted to formulate the content of the chemistry course as far as possible, listing concepts rather than materials. This made up the second section of the questionnaire and replies were obtained in such a way as to indicate whether a given concept was considered fundamental, or though taught not stressed, or omitted from the course.

The results of this section of the questionnaire are given on the mimeographed sheets. With only a few exceptions the groups, laws, theories laboratory technique, topics, and types of chemical change show a very high degree of agreement. This indicates that chemistry teachers are in harmony as to these fundamentals.

In the matter of applications in home and industry the method of scoring indicates only that a particular topic was emphasized. No great agreement could here be expected, in fact it could hardly be desired since local conditions, nearness to particular industries, varying interests of different classes and individual pupils are all factors which would make differentiation necessary and desirable. The results of this part of the questionnaire are interesting as showing what applications are most widely used, and perhaps in suggesting others, which might be profitably employed.

SUMMARY OF QUESTIONNAIRE.

Aims of Chemistry:	Unqualified Agreement	Slight Modification
Aims of Elementary Chemistry in the High School	37	5

Concepts:	Considered Fundamental	Not Stressed	Omitted
I. Laws			
Dalton	40	2	0
Avogadro	39	2	1
Charles	39	3	0
Boyle	39	3	0
Gay Lussac	39	2	1
Periodic Law	31	10	1
Berthollet	28	8	6
Mass Action	26	11	5
Raoult	23	13	6
Henry	20	16	6
Faraday	19	12	11
Dulong and Petit	16	9	17
Vant Hoff	10	16	16
II. Theories			
Molecular	42	0	0
Atomic	42	0	0
Ionic	40	1	1
III. Simple Laboratory Technique			
Manipulation	39	3	0
Tests for Ions	37	5	0
Titration	32	9	1
Cleanliness and Order (Added)	1		
IV. Topics			
Elements, Mixtures, and Compounds	41	1	0
Metric System	41	1	0

Matter and Energy	41	1	0
Solution	40	1	1
Anhydrids	40	2	0
Valence	39	3	0
Nitrogen and Carbon cycles	38	3	1
Carbon Compounds	34	8	0
Hydrates	32	10	0
Allotropy	30	12	0
Osmosis	26	7	9
Colloids	24	10	8
Isomerism	22	14	6
Crystalloids	21	12	9
Radio-activity	20	16	6
Critical Temp. and Pressure	17	12	13
V. Types of Chemical Change			
Oxidation and Reduction	41	1	0
Hydrolysis	41	0	1
Metathesis	40	2	0
Catalysis	40	2	0
Electrolysis	38	4	0
Equilibrium	37	5	0
Fermentation	36	6	0
Activity Series	33	8	1
Photosynthesis	33	9	0
Added			
Common metals and groups	1		
Exothermic and endothermic changes	1		

VI. Applications in Home and Industry

Sanitation and Health	26	Matches	18
Foods and Nutrition	25	Electroplating	17
Metallurgy	25	Textiles	17
Water Purification	24	Paper	17
Fuels	22	Refrigeration	17
Cement	22	Illuminants	17
Lime	22	Paint	17
Antiseptics	22	Laundering	17
Disinfectants	22	Abrasives	15
Glass	21	Insectitides	15
Sulphuric Acid	21	Fungicides	15
Pottery	20	Inks	11
Bleaching	20	Cosmetics	7
Adulterants	20		
Preservatives	20	Added	
Photography	19	Alloys	1
Drugs	19	Oils, Resins and Gums	1
Poisons	19	Leavening Agents	1
Antidotes	18	Sugar	1
Dyeing	18	Coal Tar	1
Explosives	18	Rubber	1
Fertilizers	18	Leather	1

"Aims in Chemistry Teaching":

1. The Awakening of the Minds of Pupils to the Possibilities of Achievement.

Our American youth are using only a very small fraction of their powers in study. We must stimulate, energize, motivate, and galvanize them into a greater exercise of mental power. We must get them to be-

lieve the fact that lack of effort is the main thing that keeps them from success.

2. The Understanding and Use of the Scientific Method of Procedure.

"To find the facts and know the truth." The only method that "brings results."

3. Acquisition of Knowledge which Serves as a Basis of Skills.

"Knowledge is power."

4. The Comprehension and Understanding of the Phenomena of Life

If the first three aims are achieved, then the pupil has arrived at the goal of self-realization. He is ready to believe with you that work is "man's greatest blessing." Drudgery is banished by intelligence. Common-places are wonderful. He is a socialized being, ready for world citizenship.

5. Recognition of Moral Law.

The inculcation of moral law by the concepts of a well-ordered universe. "Whatsoever a man soweth, etc."

II. "Fundamentals in Method, New and Old," Mr. C. J. Pieper, University High School, Chicago. Summary: The early lecture method of teaching chemistry created in the students a real interest in the subject, and gave the teacher the opportunity to thoroughly organize the subject matter, emphasize the essentials, and establish relationships between facts and principles. The course was intensive and in the end the student was able to see it as a continued story with each chapter in its proper order and setting.

The text book method followed quite naturally as the science developed and more extensive courses were required. The lecture method and the text book method are not the natural method of learning, and the slower students, especially, did not thrive on the predigested knowledge administered in predetermined doses.

The laboratory method was then developed and the student was asked to discover every fact for himself and to verify every principle. No account of economy of time was taken, and no effort made to relate the laboratory work to the larger topics or problems. Usually there was no relation between the laboratory and the class work.

The present method used by the progressive teachers is a combination of the good features of the lecture, text book and laboratory methods. Subject matter is of secondary importance. The primary aim is to develop the scientific point of view, the ability to see and solve problems. Each problem is attacked in the manner that promises, in the opinion of the teacher, to give the desired results with the greatest economy of time and effort.

Opinions of teachers as to the best methods of attacking certain problems differ widely, and must differ so long as they remain mere opinions. Teachers must apply the experimental methods of their own science to their teaching, and thus secure facts on which to base judgments as to the best methods of presenting topics.

The future course in chemistry will be a course of solving chemical problems, of establishing chemical concepts. Each problem presented in discussion, assigned reading, lecture or demonstration, will be given by the method that trial proves to be most successful in arousing interest. The problems should be large enough to include many smaller problems and topics, so as to enable the student to see the broader relationships. The evidence needed to solve a problem will be gained in any way possible, demonstration, experimentation, reading, or consulting authorities. All experimentation must be carried out with a clear purpose in the

students' minds. Experimentation should not be resorted to when assigned reading or demonstration would yield the evidence in less time and more certainly. There should be frequent short discussions during and after the gaining of evidence. The teacher should collect exhibits, charts, descriptive pamphlets of industries, city, State and Government reports and bulletins, etc., and should classify and index all this matter so that the students can consult it without loss of time. The student will keep a comprehensive notebook, containing laboratory notes, class notes, text notes, and notes on outside readings, trips, etc.

As problems for experimental teaching, Mr. Pieper suggested the following:

1. Notebooks or no notebooks.
2. Notebooks on laboratory experiments only, or complete notebooks on course.
3. Diagrams and drawings of apparatus, or none.
4. Group versus individual laboratory work.
5. Homemade apparatus versus ready made.
6. Notes in laboratory versus notes written at home.
7. Notes graded with pupil, versus grading in absence of pupil.
8. All work in laboratory and class room and no home work, versus present plan with some home work.
9. Demonstration versus individual experimentation.
10. Oral directions versus printed directions.
11. Projected illustrations versus text-book illustrations.

III. Round Table Discussion of Fundamentals. Dr. A. L. Smith, Englewood High, Chicago. The complete notebook on the course suggested by Mr. Pieper should be separate from the regular laboratory notebook. The laboratory notes should be written in the laboratory and not outside, for the work done outside is likely to be copied.

Mr. Pieper. The laboratory notes should be written in the large notebook, and not in a separate notebook. The teacher needs examine only parts here and there. At University High School the complete notebook is being tried out by one class, while another class of the same grade is following the old plan. Results so far indicate that the complete notebook is a great help to the students. The classes number 18 and 23, and have seven periods a week.

Mr. Frank B. Wade, Shortridge High School, Indianapolis, Ind. One lesson to be learned from the old lecture method is that we should abridge our courses and not try to cover too much subject matter. The immaturity of the high school pupil is an additional reason for the failure of the lecture method. Frequent repetition is needed to fix the fundamentals, and we would probably have better success teaching the theoretical parts of chemistry if we took the time to permit our pupils to acquire many facts and then generalize the laws, and imagine theories to account for them. In the laboratory the sections should be small enough to permit the teacher to get around often enough to be sure that every student knows definitely what he is doing. If the work in hand is treated as a project we will be most likely to be guided into a correct blending of the different types of method. If we can get a member of the class to invent our projects, all the better, but if projects are not forthcoming, let us invent our own. After a student has made such a marvelous notebook as Mr. Pieper describes, he could lose the document itself without suffering great loss, for its chief value to the student is in the making of it. Experimental teaching is the only way to arrive at definite knowledge as to best methods to use. The value of repetition at protracted intervals was shown by Prof. Arthur L. Foley, of Indiana University, in a paper

read at a recent meeting of the Indiana Teachers Association, in which he reported on the results of hundreds of examinations in physics given to entering freshmen at Indiana University, and in which he stated that those who had had both chemistry and physics in high school were quite uniformly successful in working problems based on Boyle's and Charles' laws, while the others as uniformly failed. The advantage of having an opportunity to review and to use in a new connection at a somewhat later time, and after some considerable mental development has intervened, any portion of knowledge, is apparently very great.

Mr. S. R. Wilson, Culver Military Academy, Culver, Ind. It is very difficult to make pupils realize the real meaning of chemical terms and formulas. Few ever get the notion that H_2O means wet.

Mr. B. J. Rivett, Northwestern High, Detroit, Mich. Used to have notebooks written up at home, but there was too much copying. When more time was allowed for the subject the notes were written up in the laboratory and a great improvement resulted. Notes ought to be corrected in the laboratory also, as this is a great saving of the teacher's time and energy, and makes it easier to call the pupil's attention to errors of fact, conclusion, English, spelling, etc. But where can one get the time for Mr. Pieper's complete notebook?

Mr. Pieper. Abbreviate the course.

Mr. Wm. Tydeman, Ottawa High School, Ottawa, Ill. An interlinear notebook is working out very nicely at Ottawa.

Mr. C. M. Wyrick, Crane Junior College. When teaching high school chemistry had the pupils provide a pad and carbon sheet. All notes were written in laboratory, pupil keeping the carbon copy for preparation for recitation. Four experiments a month were written up completely, rest only briefly. No copying.

Mr. W. F. Roecker, Boys Technical High, Milwaukee, Wis. Should the notebook be taken seriously in grading a pupil? Doesn't use it any more in making up grades, but relies on tests, oral and written.

Mr. Pieper. Assigns value varying from one-tenth to one-seventh to the notebook. In a questionnaire reported on at the Columbus meeting a few years ago, 83 teachers put the systematic arrangement of data, explanations and conclusions, first as the aim of the notebook; (2) fixation of essentials by repetition; (3) formulation of concepts of individual experimentation; (4) (very low) form of record; (5) record for future use.

Mr. Rivett. At Northwestern High School, Detroit, the class usually uses the first 45 minutes to work an experiment, and then the last 40 minutes are used in writing up and examination by the teacher. Classes number 24 to 30. Probably do not do as many experiments as in most other schools. Those who finish early study the text for next recitation. The slow ones come in extra time. Motivates experiments by discussion at beginning of laboratory time, or sometimes assigns it in advance. Each experiment should be approved.

Mr. Wyrick. Writing the notebook is important training for after-life. Many workers must hand in reports to their superiors, and a poor report may easily discredit good work. Pupils need the training in making reports. Grade it to show it is worth while.

Mr. R. E. Davis, Lane Technical High, Chicago, Ill. It is impossible to examine and grade notes in the laboratory if the class is large. Has notes written in the laboratory in pencil or ink, and insists on having the notes left at the end of the period. Notes must be written in good English, full enough so that a person familiar with chemistry could tell what was done, what happened, and conclusions reached. Reads and grades them as carefully as he can find time for. Special interviews with those whose notes show lack of understanding.

Mr. R. W. Osborne, Francis Parker School, Chicago, Ill. The trouble with the ordinary notebook is that the pupil knows that it will not be of any future use. The complete notebook would be valuable, as the pupil can see a future use.

Mr. G. P. Drueck, Jr., Senn High, Chicago. In addition to the laboratory notes, the notebook should contain a summary of the work in the textbook, the problems worked, and a summary of outside reading. Crowding the course into one semester as some do is not a good plan, as it does not give the ordinary pupil a chance to assimilate the matter studied. It would be better to spread it out over several years, correlating it with the other sciences, as recommended by Dr. Millikan.

Mr. Pieper. The notebook used at University High School is loose-leaf, and the experiments are indicated and numbered, to distinguish them from the other matter.

Mr. Wilson. If the notebooks are used as a basis for the tests, the pupils will save and value them.

Mr. B. W. Truesdell, Wichita High, Wichita, Kas. Have more girls than boys in chemistry classes. Should course be differentiated to suit?

Mr. K. C. Fitch, Englewood High, Chicago. Girls are segregated at Englewood, using the same text as boys, but different illustrations are brought up in class. Intend to develop different course for household chemistry when the new laboratory is ready. Less theory, little metallurgy, cement, etc., more carbon compounds and food chemistry. Did try out a special text and manual, but not satisfactory.

Mr. Truesdell. Are any schools giving a second year of chemistry? At Wichita have given a third semester course in food chemistry.

Mr. C. C. Whiteman, Froebel High, Gary, Ind. Five boys are taking second year work, qualitative analysis and sanitary chemistry.

Mr. J. M. Kurtz, Goshen Senior High, Goshen, Ind. The study of chemistry is made unnecessarily hard for pupils by the fact that we start them off with gases, and they are wholly unfamiliar with this state of matter. We ought to try to start them off with something with which they are familiar.

Mr. Tydeman. Most pupils can handle volume reduction problems if they involve only one of the laws, but get muddled when corrections are to be made for both temperature and pressure.

Mr. K. J. Stouffer, Wayland Academy, Beaver Dam, Wis. Best way is to send pupils to board and give them problems until every one is perfectly familiar with the process. Review occasionally.

Mr. Wilson appointed the following committees: Nominating Committee: H. R. Smith, Lake View High, Chicago, Ill.; L. L. Hall, Morgan Park High, Chicago, Ill.; S. A. Buckborough, Evanston High, Evanston, Ill.; Resolutions Committee: B. J. Rivett, Northwestern High, Detroit, Mich.; B. W. Truesdell, Wichita High, Wichita, Kas.; C. D. McLouth, Muskegon High, Muskegon, Mich.

IV. "Plans for Next Year's Work." Herbert R. Smith, Lake View High, Chicago, Ill. The committee on the reorganization of the teaching of chemistry presents herewith a formal report of the past year's work.

It has held five meetings with a full attendance of the committee, and four meetings with partial attendance. The chairman has met with the general committee on each of its five sessions.

Mr. Osborne has already reported on the work of the committee in formulating aims and listing principles and concepts and fundamental subject matter, and has given the results of the questionnaire, and this section has voted to approve this section of the report of the committee.

This list of fundamentals should be upheld by all possible means as

necessary to any standard course in first year chemistry. Teachers should so conduct their classes as to secure for each pupil of passing grade a fair working knowledge of such fundamentals. This list of fundamentals should be a suitable basis of knowledge for college teachers to build upon, and it should be able to function equally well in whatever vocational activities the possessor of it might attempt.

It is desirable that the list of fundamentals be kept sufficiently short to occupy no more that five or six months of the school session, in order that every teacher may be at liberty to choose further topics in the study of chemistry that may be of particular local interest. It will be desirable to expand the list of fundamentals into such detail that it may be a working syllabus for the less experienced teachers.

A list of cardinal points in the teaching of chemistry was sent out in the next letter to all who had responded to the first letter:

Methods in Teaching Chemistry:

I. Attack, or Approach of Topics.
  A. From daily life phenomena. (inductive.)
  B. From generalized statements or definitions. (deductive.)

II. Means of Approach.
  A. Through the pupil's laboratory experiment.
  B. Through the text book.
  C. Through the teacher's demonstration experiment.
  D. Through field trip observation.
  E. Through illustrative materials. (commercial exhibits.)

III. Considerations in Organizing and Presenting Material.

A. The Laboratory.

1. The pupil should know the general purpose of the experiment and have some motive for doing it.

2. A permanent record, preferably in ink, should be made as the results are obtained, together with deductions therefrom.

3. No questions should be asked in the experimental directions that require the use of a text or reference book.

4. The text book, as now constituted, should not be consulted by the pupil during the performance of an experiment.

5. While the class is at laboratory work, the teacher should be directing and assisting pupils, and not merely purveying materials.

6. The pupil's record should be corrected by himself under the direction of the teacher, and rewritten at the pupil's option.

7. It is desirable to keep the class together in laboratory work for greater emphasis. Optional work is desirable for rapid workers.

8. The pupils should be taught manipulation, cleanliness, and order in a very definite manner. This should not be incidental.

9. Some experiments are better as teacher-demonstration in order to save time and material, to teach manipulation, too difficult for pupil, and danger to inexperienced persons.

B. The Recitation.

10. The assignment should be clear and definite. It is best that careless pupils should take it in written form.

11. Pupils are prone to procrastinate. To require assignments to be prepared in written form brings a better pupil effort.

12. The lecture method is obsolete. The recitation should not be all quiz. Questions should be by pupils as well as the teacher.

C. General.

13. Topics for study should be chosen, first from a consideration of what is most fundamental; second, from local needs of pupils.

14. The above topics should consist of larger groups of ideas than

is usually presented, e. g. efflorescence, deliquescence, desiccation and sympathetic ink may well be grouped under general head, "hydrates."

15. The text book should function as a source of supplementary information not readily available by experiment.

16. The library should support the text book work, especially in regard to topics of modern importance, and arouse further interest.

17. In all science education honesty should be held paramount to all other considerations.

18. Home projects should be encouraged. Materials might be furnished at cost to pupils.

19. Science clubs are a decided help in securing pupil interest in chemistry. Where chemistry is elective they should be organized.

20. Field trips are profitable if well planned, conducted, and do not interfere with the work of other subjects.

21. What can *you* say further about method?

Fourteen replies were received which clearly showed that further discussion was necessary on this most important phase of teaching. Accordingly the Friday afternoon section meeting was shaped to afford opportunity for discussion by all chemistry teachers present at the annual meeting.

The committee further recommends that general plans be made at this meeting for trials and tests of methods by all teachers of this section during the coming year. The committee has proposed five plans, and asks that every teacher present write his name, school, address on a slip of paper, and indicate thereon which of these plans he would like to work on next year.

Testing Our Results of Teaching:

Our neighbors having gardens have expressed conflicting views as to which variety of potatoes were the best. We are quite certain that they have not considered all the factors which affect the yield.

So we quit asking our neighbors and turned to Nature, viz:

We planted five varieties the same season in parallel rows and gave each row the same cultivation. Then we knew that the yields, 40-45-60-60-80 pounds, differed by reason of the difference in variety.

While it is not so easy to test the results of our teaching, yet we can draw our conclusions from carefully collected evidence. We are exponents of the scientific method and should use more if we believe in it. Following are some plans for a more critical study of our methods of teaching:

Plan No. 1. To determine the relative efficiency of the laboratory and the teacher-demonstration methods of presenting topics to pupils.

While the laboratory method is generally accepted as the better one, yet such conditions may prevail as to largely nullify its value to pupils. In this plan direction sheets will be prepared for each pupil of one class to use after the usual laboratory plan. Then another class will take up the same subject by a prepared lecture with suitable demonstrations. Then each class will be tested by the same set of questions. This critical study of results will have a most helpful influence upon the instructor. To eliminate differences of personnel in classes the plan can be alternated with each class.

Plan No. 2. To test the relative values of a single vivid presentation of a fundamental topic as compared with the review and frequent reference plan (the spiral method).

Each plan is to be used entirely with separate classes and the results tested by an appropriate set of questions.

Plan No. 3. To test the power of pupils to apply the knowledge obtained in the study of chemistry.

A set of questions is to be devised whose correct answers will not depend on memory but upon the experience with principles. The questions will parallel the problems that the pupils have had; but will not directly suggest the principles involved in the wording of the questions, such as: How would you proceed to determine which of two elements was the most active chemically?

Plan No. 4. To determine the degree of uniformity of the training in chemistry by teachers in general.

A standard set of questions is to be adopted and supplied to all schools cooperating. They are to be used for all classes in chemistry at the end of each semester. The papers are to be reviewed by a small group of teachers, and the results tabulated.

Plan No. 5. To test the pupils progress in acquiring skill in things chemical.

The short time test, as detailed in the current number of School Science and Mathematics, November 1919, is given to each class each week.

Query No. 1. Can we find intelligence tests that will show to us the measure of mental training that the study of chemistry affords?

Query No. 2. What is the biggest problem that you have difficulty in solving in teaching chemistry?

The writer would like any suggestions of method or helps that will insure a larger percentage of pupils coming to class each day with a faithful effort at preparation. While about to adopt a plan of assignments that require a written preparation, yet he is aware of the consequent labor of examining these daily reports and also the fact that some will copy from others.

There is more to say but it is "your move" first.

In conclusion the committee wishes to call attention to the general unsatisfactory condition of what may be called the second half of first year chemistry. As found in the average text book, it is little more than a very much condensed cyclopedia of the metallic elements, and whatever information is given is so difficult of comprehension by the pupil as to be almost valueless. In many cases the attempt to improve it by what is styled "applications" only makes the information more confusing.

The laboratory work based on the reactions of the metals leading to the study of qualitative analysis has no place in the first year's study except in technical schools where the pupil will have need of analytical skill. A group study of the metals is the only arrangement that can be justified for furnishing the pupil with comprehensive knowledge and lay the foundation for the periodic law. But this plan does not bring out the maximum interest of the pupils. The subject matter needs to be regrouped on the basis of life conditions rather than as a logically organized science. It should initiate in the life problems of the pupil rather than to try to find a connection with life after what may be, and many times is, a wearisome grind for the pupil. He should be able to see for himself the importance of the subject matter of chemistry, and not have to depend on the instructor's statement about its being important.

Herbert R. Smith, Lake View High, Chicago, Ill.
Raymond W. Osborne, Francis Parker School, Chicago, Ill.
Albert L. Smith, Englewood High, Chicago, Ill.

It was moved and seconded that the reorganization committee be continued for another year.

Saturday Morning Meeting, November 29, 1919.

I. The committee on nominations presented the following report:

Chairman, B. J. Rivett, Northwestern High School, Detroit, Mich.; Vice Chairman, George Sype, Austin High School, Chicago, Ill.; Secretary, K. J. Stouffer, Wayland Academy, Beaver Dam, Wis. It was moved and seconded that the secretary be instructed to cast the ballot of the section for these candidates for these offices. Carried. The ballot was cast as ordered, and the candidates declared duly elected.

II. "Chemical Warfare and Chemical Teaching," Professor Wm. McPherson, Ohio State University, Columbus, O. A very interesting account of the manufacture of poisonous gases was given, and many slides shown to illustrate Prof. McPherson's remarks. The last portion of the address was a stirring appeal to all chemistry teachers to make their teaching more interesting and vital by bringing to the attention of their pupils the many applications of chemistry to war uses. Every teacher should read this article when it appears in SCHOOL SCIENCE AND MATHEMATICS.

III. "How I Improve My Chemistry Teaching," B. J. Rivett, Northwestern High, Detroit, Mich. Much of Mr. Rivett's paper has already appeared in SCHOOL SCIENCE AND MATHEMATICS, November, 1919, in his article, "Testing Results in Chemistry." Mimeographed copies of several additional tests were distributed, as well as the following list of references for those interested in this subject. The Mayman reference was mentioned as especially valuable:

Bibliography on experimentation in methods of teaching science and testing the results of science teaching:

Methods of Science Teaching:

Ayer, F. C., *The Psychology of Drawing with Special Reference to Laboratory Work*, Warwick and York, 1916. (An attempt to show that analytical drawings have value but that representative drawings are without value.)

Mayman, E. J., *Teaching Elementary Science in Elementary Schools*, Publication 13, Div. of Reference and Research, Board of Education, New York City.

Testing the Results of Teaching—Books and Pamphlets:

Monroe, W. S., *Measuring the Results of Teaching*, Houghton Mifflin and Co., Boston, ($1.60).

Monroe, W. S., *Measuring the Results of Teaching* (Revised), Riverside Press, Cambridge, 1918.

Starch, Daniel, *Educational Measurements* (Physics Tests), Macmillan Co. (Seventy-five mutilated sentences in which correct terms must be supplied).

Seventeenth Yearbook (Part II), National Society for the Study of Education (A very complete bibliography of tests in all subjects).

Army Mental Tests, Methods, Typical Results, and Practical Applications, Bureau of Education (p. 23).

Caldwell O. W., *Science Teaching in the Gary Public Schools*, General Education Board, 61 Broadway, N. Y. City.

Testing Results of Science Teaching; Articles:

Bell, J. C., "A Test in First Year Chemistry," *Journal of Educational Psychology*, Vol. 9:199-210.

Downing, E. R., "A Range of Information Test in Science," SCHOOL SCIENCE AND MATHEMATICS, Vol. 19:228-233.

Greier, N. M., "A Range of Information Test in Biology-Physiology," *Journal of Educational Psychology*, Vol. 9:210-217.

Greier, N. M., "A Range of Information Test in Biology-Zoology," *Journal of Educational Psychology*, Vol. 9:338-342.

[1]Jones, Franklin T., Union Science Tests, Tests for Physics and Chem-

istry, Published by the author, Cleveland, O.

Lackey, E. E., "A Scale for Measuring the Ability of Children in Geography," *Journal of Educational Psychology*, Vol. 9:443-451.

Randall, Chapman, and Sutton, "The Place of the Numerical Problem in High School Physics," *School Review*, January, 1918.

Webb, H. A., "Preliminary Test in Chemistry," *Journal of Educational Psychology*, Vol. 10:36-44.

Witham, E. C., "Standard Geography Test—The World for Fifth Grades," *Journal of Educational Geography*, Vol. 9:432-442.

IV. Report of the resolutions committee.

Resolved, That the Chemistry Section of the Central Association thanks the speakers for their help and inspiration and the committee on reorganization for their efforts to improve the work of this section. We consider the problem of reorganization as the most important movement undertaken in recent years. We thank especially Professor McPherson for his excellent address.

B. J. Rivett, Benj. W. Truesdell, C. D. McLouth.

It was moved and seconded that the report of the resolutions committee be accepted and approved. Carried.

V. Discussion.

Professor McPherson. O. S. U. students and faculty took the war psychological tests. Students reported low in class work by the faculty, were also found to be low in the "nut tests."

Mr. Wilson. Students at Culver Military Academy also took the army tests, and the same results were found.

The army tests have been published in full in the *Journal of Educational Psychology*, World Book Co.

The meeting was then adjourned.

HARRY M. MESS,
Senn High School, Chicago.

[1]Not an article but form tests in the process of standardization.

MINUTES OF THE GEOGRAPHY SECTION.

The meeting of the Geography Section, Friday afternoon, November 28, was called to order by the Chairman, Mr. W. F. Headley, Austin High School, Chicago. Owing to the absence of the secretary, Miss Alberta Drew, Township High School, Joliet, Ill., Miss Anne B. Royston, High Park High School, Chicago, was appointed secretary pro tem by the chairman.

The first paper was presented to the section by Mr. Andrew Nichols, Austin High School, Chicago, on "Commercial Geography as Vocational Guidance." Mr. Nichols gave an interesting survey of the many occupations which are open to a young man or woman just leaving high school, whether in office, in the mercantile field, in the world of production, or in the technical lines and professions. On account of the very diversity of occupations that are open to the young people just entering the business world, Mr. Nichols stresses the fact that students need vocational information, rather than vocational advice. He tells us that no other subject, as commercial geography, can give information which will lead the student to decide for himself what his employment may be. A careful survey of the larger relations of industrial and commercial life is the best of all preparations for business. He mentions the wonderful opportunities in Chicago for pupils to get first-hand information on subjects of commercial geography and tells how he sends representatives from his class to railroad offices, to wholesale houses, to the International Harvester Co., to study the kinds of employment which such businesses offer. These pupils make a report of their investigation to the class. In this way the class is made a

clearing house of vocational information. Industries, rather than trades, are studied. An employee has more interest in the entire manufacturing business, if he know the whole industry, rather than if he possess technical information, alone, of the operations in which he works.

"What Changes Should be made in the Teaching of High School Geography" was the subject of a paper read by Prof. W. R. McConnell, Miami University, Oxford, O. The author reminds that the aim of se ondary education is for the training of good citizenship, and that geography has no place in the curriculum, unless in its study the boys and girls go through experiences that will make them better citizens. Geography has failed to secure a prominent place in the secondary school curricula, because it has not responded to educational demands. Its content and method of presentation has changed little during the last decade. Students are still memorizing facts and principles, isolated from all significance and from all relationship. A common method of teaching applied geography is to drill on geographic factors or principles of control, then go all over the world to find conditions, real or imaginary, in which principles or controls are seen in action. Factors and principles of geography may be taught by beginning with human activities, and then interpreting the activities, in the light of adjustment to geographic environment. We sometimes study mountain passes, for instance, rather than American history influenced by the Hudson-Mohawk gap.

Geography is the link between the social and natural sciences. On the side of content it belongs in a group with history, civics, political science, sociology, and commercial and industrial education. All these subjects aim at adjusting man to his environment. The basic point of view of geography is social sympathy; and genuine interest in other people, which leads to cooperation with them, has its foundation in a knowledge of their surroundings and activities.

The kind of geography needed is that which will aid in a solution of problems arising in connection with such things as industrial legislation, banking and finance, supply and demand, reciprocity, free trade, protection—all current international questions, which is fundamental preparation for intelligent and responsible citizenship.

The kind of geography to be taught in secondary schools should be neither physical nor commercial, altogether, but should be applied regional geography, a study of geographic factors that enter into the historic, economical, social life of the people of various countries of the world.

Furthermore, we should do more with the problem method of teaching. Its use is a movement in education of great significance. Educators are favoring a wise use of the problem, because it leads to the selection and disentanglement of the primal factors in a situation, and aids the teacher in bringing into focus of conscious attention basal facts and principles which would otherwise be lost in a mass of irrelevant detail. Our text books will be properly used when the material in them is made use of in the solution of some vital problem.

Mr. Chas. C. Colby, University of Chicago, in a "Presentation of Outline of Unit I, Principles of Geography," gave the following synopsis:
Central point of view:

1. Where do people live.
2. Why and how do they live there.

Forces:

1. Physical Environment	2. Social
Position—area	Race
Climate, surface	Religion
Soil, water, resources	Education

Mineral
Coast line
Plant life
Industrial development
Economic condition

Geographic Sequence:
1. Physical environment.
2. Industrial development.
3. Social conditions.
4. Political conditions
5. Density, character of population

Types of occupations:
Fishermen—Farmers

Mr Colby further suggests that we may introduce the subjects of climate, surface, drainage, soil, under titles that lie within the student's experience. For instance, "The Farmers of Illinois" may introduce a study of the plain region; "Dairy Farming in Holland" may be the title under which a delta plain may be taught.

Mr. John Calvin Hanna, Supervisor of High Schools, Springfield, Ill., read a paper on "Scope of High School Geography." He tells us that geography is an essential subject for citizenship, and that, although it is taught in the elementary school, it should find a place in the last year of high school, giving fresh information on geographic material as the student enters the careers of the world. It surely belongs there as a full unit of work, he thinks, instead of as a half unit in the ninth grade. Here, in the twelfth grade, he suggests, let it be taught as a science with practical applications. What science, furthermore, has so many practical applications, so amazingly varied? Here, as a science in the twelfth grade, let it be taught, with library studies of books and current periodicals and true laboratory thoroughness in making independent observations and drawings and recording definite conclusions.

Geography, he observes, is linked with commerce and transportation. The masters of these matters know geography and utilize it. All civic and social institutions and activities have their roots in, and their fruits determined by geography. An enthusiastic member of the Woman's Club must cram up on geography; an aviator literally "goes over the map"; the president of the church missionary society must know something of Laos, or Chosen, or the Congo, or Mesopotamia, or whatever her heart is in; he who reads the newspaper must pass an examination on a wide stretch of geographical knowledge, or must "skip it," as other stupids do, when he comes to something unfamiliar, because of his ignorance of geography.

Mrs. Gertrude Morse, Harper School, Chicago, presented in a paper what the various committees of supervisors, principals, and teachers have done in the past few years in trying to make a satisfactory course in geography for elementary schools of Chicago. She spoke of the new point of view of geography study, in which the emphasis is placed on man and his accomplishments, industrially and commercially. She further lamented the fact that the new course of study had not been well tried out on account of the lack of suitable text books and equipment.

The "Report of the Earth Science Committee of Reorganization" was given by Mr. Jas. H. Smith, Austin High School, Chicago. Unit I of his report was given by Mr. Colby in an earlier paper. In the following synopsis, he gives outlines of Unit II and III:

Unit II.

A. The Chief Commodities of Commerce.
   I. Products of the forest; lumber, rubber, cork, etc.
   II. Products of hunting and fishing: furs, fish, etc.

III. Products of the grazing lands: wool, hides, meat.

IV. Products of the farm, orchard, and garden: wheat, corn, oats, rice, rye, barley, sugar cane, suger beet. Potatoes and other root crops, and vegetables. Fruits of tropic and temperate lands. Oils, dairy products and meats.

V. Products of mines, quarries, wells.

The mineral fuels: coal, petroleum, gas.

The metals: iron, copper, lead, zinc, mercury, platinum, etc.

Clay products.

VI. Products of manufacture: power, iron and steel, textiles, foods, furniture, chemicals, etc.

B. The Movement of Commodities in World Commerce.

I. Advantage of position with reference to trade.

II. Development of great land routes of trade.

III. The great ocean routes.

IV. The organization of ocean commerce.

V. The development of market centers.

In Unit III, Commercial Countries, it is proposed to study a selected list of commercial countries, possibly grouping them as,

a. Powerful countries

b. Populous countries

c. Countries with a large commerce.

d. Countries where people live in a very different geographic environment from that of the United States.

The time required and the scope of these courses will be discussed in this program by Hon. John Calvin Hanna, Supervisor of High Schools, State of Illinois. The unit Courses will probably be adaptable to either semester of year programs. As a minimum requirement your committee agrees that, above the eighth grade, not less than one year of geography should be required of all pupils; that economic geography should be required in the ninth grade for pupils in commercial and industrial courses and elective in other courses; and that Commercial Countries should be required in eleventh or twelfth grade for all pupils in four year commercial and industrial courses and elective in other courses.

Science teachers should have in mind the legitimate demands of other subjects, and should be reasonable in their own demands. Nevertheless they should recognize the fact now made plain to all educators that much that has been taught in the past in our schools must give way to subjects of higher value. Secondary School Circular No. 3, U. S. Bureau of Education, gives as one of the five objectives of science in high schools the following:

In order to encourage high school students to elect more work in science, and at the same time to lay a foundation for a general appeal to science and its methods, every effort should be made to arouse a lively interest in science, particularly in grades 7 to 9.

During the year the committee has collaborated with two other committees working upon the same problems, namely, the committee on first year science of the Chicago high schools; and the committee on course of study in geography, of the Conference of Schools Affiliated with the University of Chicago.

The Chairman appointed a committee of nomination: Mr. D. C. Ridgely, State Normal School, Normal, Ill.; Miss Mabel Sykes, Bowen High School, Chicago; and Mr. J. M. Large, Township High School, Joliet, Ill.

On Saturday morning, Mr. W. H. Spurgin, Hyde Park High School,

Chicago, gave a paper on "Mapping by Aerial Photography." He spoke of the flyers enlarged range of vision. On a clear day, a flyer 6500 feet above Lansing, Mich., could see portions of Lake Michigan, Lake Huron, and Lake Erie. The area included in a photograph depends, of course, on the altitude of the flyer. He pointed out many short-comings of this kind of photography. For instance the top of high elevations, being nearer the camera, appear larger in the picture. High altitudes above 10,000 feet involve temperature changes which are likely to disturb the focus and retard the action of moving part. Although the aerial photographs are not accurate, they may become a valuable aid to established methods of map-making. Given a base map with a sufficient number of control points, cultural details may be gathered with amazing speed, completeness, and ease. Scarcely forty per cent of the United States has been satisfactorily mapped. Much of the detail of the remaining work may be obtained from the air. Old maps may be brought, and kept up to date. Changing coast lines may be mapped with sufficient accuracy, and as frequently as necessary. One of the oil companies with large holdings in British Columbia had spent a considerable sum exploring a mountainous region in search of a pass through which a pipe line might be run. A year ago they were considering making an aerial survey. Another improtant use of aerial photography, he suggests, is that of mapping air routes. There seems to be good reason for believing that air travel on a commercial basis, will be largely confined to definite lanes, in order to take advantage of established landing places.

Mr. F. E. Williams, University of Wisconsin, addressed the meeting on "Steps Necessary to Establish Geography as a Fundamental High School Subject." Emphasizing the importance of the subject of geography, he suggests that the first step is to get good text books. Our text books at present are inadequate. The greatest factor, however, he thinks, is in the person of the teacher. Geography cannot confine itself between the covers of any book; so it must have an especially wide awake teacher who is always on the lookout for interesting material. Too long has the class in geography, he observes, been shifted to the teacher with a free period. A teacher of average science must be a specialist through long active work in his particular study; but the geography teacher must have a background of history, dealing particularly with exploration, settlement, and progress, as well as a knowledge of soils, plants, minerals, and configuration of the land.

But no amount of specialization will ever make a perfect teacher, unless alertness, observation, initiative are there. There is a fund of information, to enrich the student's knowledge, in every periodical, dealing with world topics.

The position which geography has reached in the colleges and universities, he reminds us, is a further aid. As a high school study it should now receive an impetus from the higher institutions, where it is permanently established. The number of students taking geography in the universities has increased by leaps and bounds.

Mr. D. C. Ridgely, chairman of the nominating committee reported as follows: For chairman, Mr. Wellington D. Jones, University of Chicago; For vice-chairman, Mr. R. R. Robinson, Joliet Township High School; For secretary, Miss Anne B. Royston, Hyde Park High School.

Mr. Jas. Smith, Austin High School, introduced the subject of the appointing of a committee on propaganda, concerning the value of geography courses in high school. Mr. Williams talked in favor of such propaganda. It was moved and seconded that the retiring chairman and the new chairman of this section, together, appoint such a com-

mittee. It was further moved and seconded that this committee confer with the High School Conference of Geography of Illinois. It was moved and seconded that the reorganization committee of this section remain the same. It was also moved and seconded that the reorganization committee of the Geography Section shall continue to work with Mr. Downings' committee on reorganization.

ANNE B. ROYSTON,
Hyde Park High School, Chicago, Secretary, pro tem.

REPORT OF THE COMMITTEE ON EARTH SCIENCE IN THE REORGANIZED HIGH SCHOOL.

The work of your committee during the year has been to amplify and work out the details of the plan reported at the last meeting of the Association in November, 1918. Three Unit Courses were proposed, namely, Unit I, Principles of Geography; Unit II, Economic Geography; Unit III, Commercial Countries.

Unit I is to be presented in full by another speaker at this meeting. Therefore it is unnecessary for your committee to discuss it in this report.

A tentative outline of Unit II follows:

The Purpose, to study somewhat intimately the influence of physical environment upon man in the making of his living.

The method, a study of (a) the geographic influences in the character and location of type industries, as shown in the more important commodities of commerce; and (b) the influences determining the movement of commodities in the flow of commerce.

Synopsis of Course.

A. The Chief Commodities of Commerce.
  - I. Products of the forest: lumber, rubber, cork, etc.
  - II. Products of hunting and fishing: furs, fish, etc.
  - III. Products of the grazing lands: wool, hides, meat.
  - IV. Products of the farm, orchard, and garden: wheat, corn, oats, rice, rye, barley. Sugar cane, sugar beet. Potatoes and other root crops, and vegetables. Fruits of tropic and temperate lands. Oils, dairy products and meats.
  - V. Products of mines, quarries, wells.
    - The mineral fuels: coal, petroleum, gas.
    - The metals: iron, copper, lead, zinc, mercury, platinum, etc.
    - Clay products.
  - VI. Products of manufacture: power, iron and steel, textiles, foods, furniture, chemicals, etc.

B. The Movement of Commodities in World Commerce.
  - I. Advantage of position with reference to trade.
  - II. Development of great land routes of trade.
  - III. The great ocean routes.
  - IV. The organization of ocean commerce.
  - V. The development of market centers.

In Unit III, Commercial Countries, it is proposed to study a selected list of commercial countries, possibly grouping them as,

a. Powerful countries.

b. Populous countries.

c. Countries with a large commerce.

d. Countries where people live in a very different geographic environment from that of the people of the United States.

The time required and the scope of these courses will be discussed in this program by Hon John Calvin Hanna, Supervisor of High Schools, State of Illinois. The Unit Courses will probably be adaptable to either semester of year programs. As a minimum requirement your committee agrees that, above the eighth grade, not less than one year of geography should be required of all pupils; that economic geography should be required in the ninth grade for pupils in commercial and industrial courses and elective in other courses; and that Commercial Countries should be required in eleventh or twelfth grade for all pupils in four year commercial in industrial courses and elective in other courses.

Science teachers should have in mind the legitimate demands of other subjects, and should be reasonable in their own demands. Nevertheless they should recognize the fact now made plain to all educators that much that has been taught in the past in our schools must give way to subjects of higher value. Secondary School Circular No. 3, U. S. Bureau of Education gives as one of the five objectives of science in high schools the following:

In order "To encourage high school students to elect more work in science, and at the same time to lay a foundation for a general appeal to science and its methods, every effort should be made to arouse a lively interest in science, particularly in grades seven to nine."

During the year the committee has collaborated with two other committees working upon the same problems, namely, the committee on first year science of the Chicago high schools; and the committee on course of study in geography, of the Conference of Schools Affiliated with the University of Chicago.

The report given above has been worked out by these three committees sitting conjointly, under the chairmanship of Dr. Charles C. Colby.

Respectfully submitted,

James H. Smith,

November 28, 1919. *Chairman.*

MINUTES OF THE GENERAL SCIENCE SECTION.

The success of the program of the General Science Section was assured at the beginning of the meeting, not only because of the excellence of the papers to be given, but also because the meeting was attended by a large number of highly representative teachers, state inspectors, and others who have contributed to the development and success of the subject. Mr. Fred D. Barber, Illinois State Normal University, Normal, Illinois, chairman of the section, presided at both the Friday afternoon and Saturday morning sessions.

The first paper was presented by Mr. S. R. Lewis, Consulting Engineer, Chicago, Illinois, on "Air Conditioning in School Buildings." Mr. Lewis gave evidence to prove that the problem of school ventilation is one of temperature regulation. As long as the air around the bodies of the pupils remains within reasonable limits of the optimum condition no tendency toward restlessness or sleepiness is exhibited. The condition of the air inspired aside from its temperature is of little moment so long as it does not carry infected dust or drops of water which may cause trouble. Mr. Lewis believes that the best method of ventilation is one which depends on the displacement of air rather than on its diffusion. An arrangement whereby an air supply will rub over the bodies of the pupils in an appreciable current at such a temperature as not to cause discomfort is the most satisfactory one. Rooms in which inlets can be under fixed seats, with outlets at the ceiling giving a slow moving updraft give excellent results. This insures ventilation by displacement and not by dilution.

Interest in Mr. Lewis' excellent paper was indicated by the discussion which was led by Mr. George Mounce of LaSalle, Illinois; Dean E. S. Keene, North Dakota Agricultural School, Fargo; Miss Mabel Spellmire, East High School, Cincinnati, Ohio; Mr. C. H. Perrine, Wendell Phillips High School, Chicago; Mr. Henry Goddard, Supervisor of High Schools, Madison, Wisconsin; and Mr. C. W. Schrock, Pontiac, Illinois. The principal points brought out by the discussion were: 1. A chemical laboratory can not be perfectly ventilated by the general system. A cabinet with an exhaust above and one below must be provided. 2. Moisture can best be introduced into the air by means of an air washer, but the engineer can not be depended upon to keep the washer in operation nor to keep it clean. Another method is to inject steam. A stationary pan of water may be used provided the area is large enough. 3. A carbon dioxide indicator is the only method for testing air. The humidity should be taken at all times.

The importance and the possibilities of giving instruction in household mechanics and a plea for more applied science in our schools were the key notes of the paper on "The Use of Physical Equipment of the School Building in Class Room Instruction," by Dean E. S. Keene, School of Mechanic Arts, North Dakota Agricultural College, Fargo. Even the most modest homes now have the conveniences of water supply, heat, and light and with them a complication of domestic mechanism. Some instruction in the operation of this machinery is essential. With the use of the equipment in the school building and the assistance of the janitor, the fireman, the plumber, and the architect information can be given in methods of heating, lighting, water supply, and sewage disposal and also in the construction and operation of the parts of each.

In the discussion which followed Mr. Keene's paper, Mr. Barber, the chairman of the meeting, said that he thought in teaching applied science one should not neglect to emphasize fundamental scientific principles. Mr. Goddard of Madison, Wisconsin, said that there has been too much of a tendency in the past to develop principles and then not to give concrete applications to fix these principles in the child's mind. "One of the best things which general science had done," Mr. Goddard added, "has been to center the thought of the teacher on the child and not on the subject matter of one or more of the highly specialized sciences."

Those who still oppose the introduction of General Science because they think that it requires an expensive laboratory, should read Prof. G. A. Bowden's paper on "Possibilities of Home Work in General Science." Prof. Bowden briefly outlined a course, all of the projects of which centered around the home, for example, lighting the home, heating the home, weather and climatic conditions about the home, and others. He then developed one or two of these projects and showed their possibilities for home work. Throughout the course, Mr. Bowden finds the desire on the part of most of the pupils to make or repair something in the home. This gives new material for study, such as repair of a thermostat, construction of a fireless cooker, wiring, arrangement of switches and lamps so that lights may be turned on at the house and off at the garage, etc. Another agent which he finds valuable is a portable projecting lantern with slides and post card pictures. He allows pupils to select sets of slides and pictures bearing upon some topic under discussion and to take them together with the lantern to their homes. The pupil who takes the lantern home that evening gives the family an illustrated lecture. Mr. Bowden does not believe that the work of the

course should be confined to the home. Many problems should be given in the laboratory and in the class room.

Mr. George Mounce, LaSalle-Peru Township High School, LaSalle, Illinois, in his paper on "Some Tangible Results from a Course in General Science", emphasized the fact that the course in general science is the first opportunity which the boy and girl have had to get knowledge about the things in their environment: automobiles, kites, telephones, and the many other things which arouse a child's curiosity. The first and most important result of a course in general science is thus the creation of a boundless enthusiasm for the wonders of science. This gives the impulse which starts many pupils to reading scientific books and to investigation on their own accord. After the introduction of the course in general science, Mr. Mounce found a steady increase in the numbers of students electing the advanced sciences and also an improvement in the quality of the work done in those subjects.

After a brief discussion of this paper, the chairman appointed the following nominating committee: Mr. H. N. Goddard, Supervisor of High Schools, Madison, Wisconsin; Mr. C. E. Spicer, Joliet Township High School, Joliet, Illinois: Miss Mabel G. Spellmire, East High School, Cincinnati, Ohio.

The report of the committee on reorganization was given by Miss Ada L. Weckel, High School, Oak Park, Illinois. This committee sent out questionnaires to determine the aims of general science, the basis for the selection of subject matter, the units of subject matter, the organization of subject matter, and the use of the project method in presenting the subject. In the replies received, the problem seeing and the problem solving aim was given first choice; the appreciation aim second; and the knowledge aim third.

All agreed that the selection of subject matter should be made on the basis of facts, principles and concepts which everyone should know for his own personal welfare and on account of his social relations. About eighty per cent approved of segregation in schools of sufficient size with a selection of materials in part for (1) boys, (2) girls, and (3) as bearing on the intended vocation.

The following units of subject matter were approved by at least seventy-per cent of the teachers who replied. The units are listed in the order of choice: 1. Principles and systems of ventilation. 2. Principles and systems of residence and school room heating. 3. Sources, nature, composition and combustion of common fuels. 4. Residence and school room heating, artificial and natural. 5. Hygiene and sanitation, principles and practice. 6. Weather, including air, physical properties and mechanics of gases. 7. Microorganisms as related to foods, to decay, to soil, to health. 8. Water supply and sewage disposal, including household plumbing. 9. Mechanics as related to home and street life, "safety first." 10. Electricity and magnetism—dry cell, door bell, house connections and wiring. 11. Climate in its relation to health, and to plant and animal life.

The two following units were approved by 57 per cent:

1. English and metric systems of measurement. 2. Steam engines and gas engines.

Only 37 per cent approved of:

1. Human anatomy and human physiology as such.

Over 75 per cent expressed their preference for the organization of the subject matter in general science around natural units such as are given above, rather than around units composed of materials which are scientifically related, as is common in special sciences.

Replies indicated a diversity of opinion relative to the use of the project method in general science, some thinking it should be used exclusively, others in part, others not at all, and still others were undecided.

After a discussion of this report and the work to be undertaken by the committee during the coming year, Mr. Goddard, Madison, Wis., moved that the committee appointed last year by this section be continued for another year and that this committee be asked to formulate a plan of general science for the ninth year (first year of four year high schools) based on the project idea, and further that this plan be presented to the section in the form of a written report at the meeting of the section next year.

This motion was seconded and approved. The members of the committee on reorganization are: Mr. Fred Barber, Normal, Illinois, chairman; Mr. Ernest Collette, Chicago, Illinois; Miss Ada L. Weckel, Oak Park, Illinois.

The meeting was adjourned until 10 a. m. the next day, November 29.

The section was most fortunate on Saturday morning to have the benefits of the good judgment and long experience of Prof. Herbert Brownell, University of Nebraska, who read a paper on "The Role of Laboratory Work in General Science and the Teacher Training It Involves." After twenty-six years of training teachers for secondary schools, Prof. Brownell says that he has been unable ever to find any satisfactory substitute for the laboratory in science teaching. He strongly urges the use of carefully prepared laboratory manuals, especially in general science, which subject, he says, if taught without well defined and well sustained laboratory features fails to function properly in public school education. Trained science teachers of long experience in large city systems can well be left to choose and combine and use successfully material of their own science courses. But Prof. Brownell urges that those who are earnest advocates of the value of general science should not be blind to the fact that the future of the subject is determined largely by teachers who lack experience, teachers in the smaller high schools. In regard to the teacher, Prof. Brownell finds that the demand is no longer for teachers who have specialized in some one science. School boards are insisting on having teachers who possess general knowledge in all the fields of science.

Mr. E. B. Collette, Lake View High School, Chicago; Mr. G. A. Bowden, Cincinnati, Ohio; Mr. W. F. Roecker, Boys' Technical High School, Milwaukee; Mr. R. A. Denslow, Cicero Township High School, Berwyn, Illinois; and Mr. D. W. Lott ,Cleveland, Ohio, took part in the discussion which followed Prof. Brownell's paper. With the exception of Mr. Lott, all expressed themselves in favor of laboratory work, but not of the formal type. Mr. Lott preferred to have some formal laboratory work. Prof. Brownell thinks that the type of laboratory work given should depend upon the teacher. Some get better results with a formal type, others with a less rigid type.

Mr. John Calvin Hanna, State Supervisor of High Schools, Springfield, Illinois, presented an excellent paper on "The Place of General Science in the High School." Mr. Hanna was one of the first men to whom the idea of general science occurred, and he has fostered and watched with interest its development through a long period of years. After these years of observation he has come to the following conclusions: 1. General science has a legitimate place in the high school. 2. It should, if offered at all, be required of all students. 3. The course should be a full time one-year course, with at least one double period a week given to laboratory work performed by the pupils themselves. 4. It should be organized

with special reference to the pupil's degree of maturity, as a basis for further study and as a real introduction to the whole field of science. 5. It should come first—before the study of the other sciences. That is, it should be taken in the ninth grade. In the junior high schools it might be so organized as to run through seventh and eighth grades.

Mr. Hanna objects to the introduction of a two-year course in general science on the ground that there is not time for it. He approves, however, of two prescribed units in science, the first general science and the second one of the special sciences.

Much interest was manifested in the discussion which followed Mr. Hanna's paper, especially in the effort to determine the prescribed units in high schools. And as Mr. Hanna pointed out, most high schools are small, small high schools can not offer electives, so for the majority of pupils in the State, most of the units are required. Although, as specialists, we prefer more than two units of required science, it was evident with the claims made by other subjects that we could not hope for much more.

Prof. A. W. Nolan, State Supervisor of Agricultural Education, Springfield, Illinois, gave an interesting paper on "General Science and Vocational Education" We were interested to learn that an advocate of vocational education finds a real value in general science. In all vocational education there are three phases of instruction to be followed out. These phases Prof. Nolan termed "the three r's"—rules, reasons, and related studies. It is in the last two aspects of study that general science functions as a reference study, to give reasons, explain principles and to lead into related matter. Mr. Nolan believes that any of our standard texts may be used as a constant source of excellent reference material to give principles and enriching related studies for all the manipulative processes in the jobs of major vocations. He further thinks that in all vocational courses, general science should be required early in the course. It should precede or parallel the vocational courses for one or two years.

The nominating committee submitted the following report: Chairman, G. A. Bowden, University High School, Cincinnati, Ohio; vice-chairman, George Mounce, La Salle-Peru Township High School, La Salle, Illinois; secretary, Ruth C. Russell, Lake View High School, Chicago, Illinois.

The secretary was instructed to cast a unanimous ballot for persons whose names were submitted.

The interest shown in the meeting of the Section of General Science was such that the future of this new section of the Association seems assured. The section adjourned.

ADA L. WECKEL, *Secretary*,
High School. Oak Park, Illinois.

MINUTES OF THE HOME ECONOMICS SECTION.

On Friday, November 28, Dr. Blunt, of the University of Chicago, opened the meeting and presented Miss Trilling, also of the University of Chicago, as chairman, who outlined the work of the Reconstruction Committee of home economics. She showed how several committees had pooled their results of their investigations under the following heads: 1. Methods used in making surveys; 2. Results of these investigations, showing present status of (1) methods, (2) aims, (3) generalizations; 3. Suggestive changes in methods, aims and concepts; 4. The use of standardized tests.

Miss Helen Goodspeed, State supervisor of home economics, Wisconsin, gave as the State slogan, "Come out of the basement"—come out in body and spirit. Her statement of aims, derived from surveys was to

develop (1) skills (technical); (2) general ideas—judgments, etc.; (3) information; (4) Problem-solving ability. She submitted the following as possible aims: Training for active membership in home and community; training in power to see and to solve problems; training in appreciation of various phases of home making and in development of judgment in regard to these; sufficient training in skill to develop thorough appreciation and understanding to the end that these skills may be perfected, when desired, in home environment.

The lines of action suggested were the training of teachers for four years; placing more background of history, science, English, economics, etc., in the course of study and emphasizing home project work; accepting problem-solving method of teaching; having instructors in teacher-training schools visit in the field so as to make theory and practice one.

Nominating committee was appointed, by chairman composed of Miss Florence Williams, Richmond, Indiana; Miss Falls, Lake View High School, Chicago; Miss Helen Goodspeed, Wisconsin.

"Tests as an Aid in Formulating Course of Study" was given by Miss Florence Williams, of Richmond, Indiana.

Surveys showed weaknesses in choice and use of text books; choice and development of materials; distinction between high school and grade problems. General results from tests are: A series of promotions and demotions; change in size of classes; change in content of course; change in method; change in time allowance.

Discussion was led by Miss Emily Frake of Parker High School, Chicago, who gave some of her personal experiences in problem-solving method. She gave the value of tests as a help to the teacher in checking up on herself, and as a help in stating definite aims.

Miss Rosa Biery, of the University of Chicago Elementary and High Schools, spoke on "Economics in Home Economics Courses." She gave the following phases of economics as those which she has found valuable in junior and senior high-school classes: 1. The effect of changing economic and industrial conditions upon home life and upon women; 2. The influence of women and girls as spenders in furthering economic prosperity of the world; 3. The attitude of searching out facts concerning things the weighing of values.

The speaker showed how she made use of these phases in the presentation of work in the high school, largely by the problem-solving method.

Meeting adjourned until Saturday, ten a. m.

IVAH M. RHYAN,

Head of Home Economic Department, Terre Haute, Ind., Normal, Secretary pro tem.

On Saturday, November 29, at 10:30 a. m., Miss Blunt, of the University of Chicago, presided.

Miss Falls of Lake View High School read the following report for the nominating committee: Harriett Glendon, Lewis Institute, chairman; Treva E. Kauffman, Columbus, Ohio, vice chairman; Maude M. Firth, Davenport, Iowa, secretary. The report was accepted as read.

The section voted that the new chairman appoint some one from the section to serve as chairman of a committee on membership, cooperatind with the membership committee of the whole association.

It was moved that a vote of appreciation to the reconstruction committee for the work they had done during the past year be recorded. Carried unanimously.

Following this, Miss Minnie L. Volk, of South H. S., Columbus, Ohio, read a paper "The Correlation of Art and Household Art," in which she urged the necessity for art in all public schools as an integral factor in the

process of socialization. Art training comes not only from the actual drawing itself, but from the unconscious training which comes with good surroundings in class rooms,school grounds and the community in general.

Drawing in itself should be subordinated to the teaching of laws of harmony, color, balance, unity. Costume design is one very important means of teaching art in the high school. The aim of the costume design in South High School is to develop good taste, acquire a knowledge of the evolution of line in costume, the use of appropriate and becoming materials, styles and colors. As a result of the teaching of costume design, there is a marked change in taste in dress among the girls of the high school. The students take charge of the costumes in the dramatics given by the high school.

The next paper, "The Value of Animal Experimentation to the Human Family" was read by Miss Emma Francis, of Battle Creek Sanitarium, Battle Creek, Michigan, and accompanied by an extensive exhibit of rats fed on different experimental diets.

Animal experimentation has taught us that we cannot choose our food indiscriminately from our abundant store. Many valuable constituents are wasted and lost in processes of manufacture and preparation.

In the laboratories of the Battle Creek Sanitarium they are endeavoring to find the lack in the vegetarian diet fed to rats by Slonaker of Leland Stanford University as early as 1908, on which the rats had failed to grow as they had on an omniverous diet. The food combination consists of cracked corn, cooked corn, bread, almonds, lettuce, baked beans, muffins, mashed potatoes, macaroni, oatmeal and buckwheat cakes.

To determine the inadequacy of such a diet, the following additions were made: (1) butter fat; (2) butter fat and fifteen per cent soy bean for complete protein; (3) butter fat and fifteen per cent soy bean and fifteen per cent mixture of greens. The addition of butter fat has given no better growth than the original diet. The second addition (butter fat and soy bean) increased the weight slightly and improved the appearance of the tail. The butter fat, soy beans and greens caused half the animals to double in weight in a month and the others are making normal gains and all are in fine condition.

Animals on diets with and without milk have been found valuable aids in illustrating talks to school children and to mothers concerning the value of milk for young children. The addition of one tablespoonful of milk a day to a diet consisting of potatoes, greens and bread causes two to three times as much growth as was obtained without the milk, and this one tablespoonful was thought to correspond to the cupful of milk a child might get with his school lunch.

Discussion of this paper was postponed until after the next paper by Miss Mary E. Freeman of the Chicago Public Schools, "Malnutrition of Children and What the School Can Do to Overcome it."

The responsibility for getting nutrition information across to the children and mothers lies chiefly with the elementary school teacher by virtue of the fact that she has both boys and girls under her supervision and has them for more periods a day or week than the home economics teacher, which gives her opportunity to correlate the nutrition work with her daily lessons.

In this particular instance, the grade concerned was the sixth. The children's interest in nutrition was caught and held by the fact that there were 27 days of absence the first month and 55 the second. The children decided for themselves that sickness was the only legitimate cause of absence and made the natural opening for the discussion of what a child must do to keep well. In one month's time, the breakfasts and hours of sleep had noticeably improved as shown by daily reports.

Very definite training in proper habits of eating and living can thus be given the children, without even scales or measuring rods, if the elementary school teacher sees the opportunity before her and is sufficiently trained to take advantage of it.

The discussion was led by Miss Jenny Snow, of Chicago, who emphasized the need of at least one course in home economics for every elementary school teacher. Many nutrition classes are now being conducted in the Chicago public schools and the Infant Welfare Society has eight such classes.

At this time, Mr. Newbill, of the States Relation Service, and in charge of the boys' and girls' club work, spoke for a few minutes concerning the value of such club work in developing citizens.

Meeting was adjourned. SYBIL WOODRUFF,
Secretary pro tem.

MINUTES OF THE MATHEMATICS SECTION.

The Mathematics Section held two meetings, on November 28 and 29, 1919.

FRIDAY AFTERNOON MEETING.

In the absence of the chairman, Mr. Byron Cosby, of Kirksville, Mo., Mr. Marquis J. Newell, of Evanston, Ill., presided.

Prof. C. A. Epperson, of State Teachers' College, Kirksville, Mo., read a paper on "Some Problems for the School Room from the Orientation Work of the A. E. F." In this address Prof. Epperson spoke of the great difficulty encountered during the war in finding persons who knew enough about simple trigonometry to solve right triangles by means of logarithms. He said that usually one who could solve quadratic equations and use logarithms would be sent to an officer's training camp. This may indicate either that we teach insufficient mathematics or that what we do teach does not function. Prof. Epperson urged that we give more thorough training in accuracy in computation and put more emphasis upon the use of the co-ordinate system. Several problems derived from the field of orientation were cited as especially valuable for such training. In a digression from his main topic, Prof. Epperson spoke of the great advantages of the metric system and called attention to the fact that all of the men who have been in France would now favor a change from our present system to the metric system.

Mr. J. A. Foberg, of Chicago, Secretary of the National Committee on Mathematical Requirements, read the preliminary report of a subcommittee of the National Committee on "The Reorganization of the First Courses in Secondary School Mathematics." The report covers the work of the first two years of the standard four-year high school. The following two principles are made the basis of the discussion: 1. The primary purpose of the teaching of mathematics should be to develop the power of understanding and analyzing relations of quantity and of space which are necessary to an understanding of the world, and to develop the habits of mind which will make this power effective in the life of the individual; 2. The courses in each year should be so planned as to give the pupil the most valuable mathematical information and training which he is capable of receiving in that year without reference to the courses which he may or may not take in succeeding years.

The report states that the one great idea which is sufficient in its scope to unify the course is that of the functional relation. The report urges "that continued emphasis throughout the course must be placed on the development of power in applying ideas, processes, and principles to

concrete problems, rather than to the acquisition of mere facility or skill in manipulation." Hence most of the emphasis now generally placed on the formal exercise should be shifted to the concrete or "verbal" problem. Instruction in numerical trigonometry is insisted on, while in geometry informal work of an intuitive, experimental and constructive character should precede work in formal demonstrative geometry.

The discussion of this report was opened by Mr. Charles Ammerman, of the McKinley High School, St. Louis, Mo. Mr. Ammerman stated that while in general he was in hearty agreement with the report that he wished for a discussion of first, the organizing idea of the subject and second, the modification of topics. He urged that we give fewer notions but make the pupil thoroughly conversant with them, but questioned whether the idea of functionality should be one of those introduced.

During the general discussion which followed, the following persons participated: Mr. C. E. Comstock, of Peoria; Miss Marie Gugle, of Columbus, Ohio; Mr. H. C. Wright, of Chicago; Miss Ethel Jaynes, of Chicago; Mr. Collins, of Wisconsin; Mr. W. D. Reeve, of University of Minnesota; Miss Mabel Sykes, of Chicago; Mr. J. O. Hassler, of Chicago; Mr. W. E. Beck, of Iowa City, Iowa; Dr. H. E. Slaught, of the University of Chicago; Mrs. Mary Devereux, of Chicago, and Dr. H. O. Rugg, of the University of Chicago.

The following resolution introduced by Mr. J. R. Clark of Chicago Normal School was adopted:

Whereas, the preliminary report submitted to the Mathematics Section of the Central Association does so thoroughly reflect the modern and progressive tendency in mathematical education, and

Whereas, the need for a sound, thorough-going reorganization in mathematics courses is so generally recognized, and

Whereas, the weight of opinion and prestige of this body of teachers will go far toward ushering into general practice these progressive ideas, therefore be it

Resolved, That we, the Mathematics Section of the Central Association, do heartily endorse the general point of view of this report, and be it further

Resolved, That we pledge our individual and group cooperation with the National Committee by reporting our personal criticisms, (recommendations for omissions and additions to the report) in writing, to some member of the National Committee.

Mr. C. M. Austin, of the Oak Park High School, then discussed "The Organization of a National Council of Secondary Mathematics Teachers." He pointed out the lack of any organized body of mathematics teachers meeting at the time of the annual meeting of the Department of Superintendence of the N. E. A. There is a real need for such an organization to act as a coordinating force to bring together all interests and to present them before the teachers and the administrators of the country who have the power to make out courses of study. After canvassing the opinion of prominent teachers of mathematics in the country, letters were sent to the mathematical organizations asking them to appoint delegates to the N. E. A. meeting at Cleveland, Ohio.

Mr. W. W. Gorsline, of Crane Technical High School, of Chicago, moved "that this section endorse the movement of organizing a National Council of Secondary Mathematics Teachers of America and that the chairman of their section select from this group three to five members to attend this meeting as our delegates. This was seconded and carried but later it was moved, seconded and carried that the number of delegates should be five.

Dr. H. E. Slaught spoke in favor of such an organization and urged all who could do so to attend the meetings.

Mr. Newell then appointed the following nominating committee: Mr. E. L. Thompson, Joliet, Ill.; Miss Mabel Sykes, Chicago, Ill.; Mr. J. O. Hassler, Chicago, Ill.

It was moved by Miss Mabel Sykes that a committee be appointed to make a list of the mathematical processes needed in certain lines of work. This was seconded and carried.

The section adjourned.

SATURDAY MORNING SESSION.

At the Saturday morning session, Mr. W. D. Reeve, of the University High School, University of Minnesota, discussed "The Classification of Students According to Ability Shown in Psychological Tests and a Study of Subsequent Records." This report is not a final one as the experiment is not yet concluded, but Mr. Reeve is confident that children should be classified according to some test of high reliability. The report was discussed by Miss Mabel Sykes, of Chicago, Miss Ethel Jaynes, of Chicago, Mr. Comstock, of Peoria, and Mr. F. C. Touton, of Teachers College, Columbia University.

The nominating committee submitted the following report: For chairman, Mr. M. J. Newell, Evanston, Ill.; for vice chairman, Mr. W. E. Beck, Iowa City, Iowa; for secretary, Miss E. G. Parker, Oak Park, Ill.

The report was accepted and the chairman of the committee instructed to cast a ballot for the persons nominated.

The following delegates to represent this section at the first meeting of the National Council of Secondary Mathematics Teachers at Cleveland, Ohio, were appointed: Dr. H. E. Slaught, University of Chicago; Miss Mabel Sykes, Bowen High School, Chicago; Mr. W. W. Hart, University of Wisconsin; Mr. C. E. Comstock, Bradley Polytechnical Institute, Peoria, Ill.; Mr. W. E. Beck, High School, Iowa City, Iowa.

Mr. Newell read a clipping from one of the Chicago papers which gave an erroneous report of the Friday afternoon session. Mr. J. R. Clark, of the Chicago Normal School, and Mr. Wehrmeyer were asked to write a reply correcting this statement.

The session adjourned at noon. ELSIE G. PARKER, *Secretary.*

MINUTES OF THE PHYSICS SECTION.

The meeting was called to order by chairman Fred R. Gorton, of Michigan State Normal School, Ypsilanti, and proceeded to take up the regular program.

"Preliminary Intelligence Testing in the Department of Physics, University of Chicago," Dr. Harvey B. Lemon: The notable increase in the attendance in all departments at the University has been especially marked in the physics and chemistry departments. Thus in the present year in the junior college in eight physics courses there are or will be 36 sections of about 24 students each, meeting nine hours per week.

Under these conditions it seemed the part of wisdom to test the ability of all those beginning the subject so as to eliminate probable failures at the start. At the first meeting of the classes, a form card is filled out by each entrant, which gives: Name; age; university classification; year in university; high school physics taken; when; where; what text book; previous mathematics in high school; in college; previous science courses in high school and college; other courses being taken simultaneously with present course; why is the student now registered for this particular course?

At this first session an efficiency test is also given. Questions are dictated and answers are written at once with only a brief time for thought or computation. These questions cover high school physics with some arithmetic and algebra. For example: How much current does a 50 watt lamp consume on a one hundred volt circuit?

What is Boyle's law?

How many degrees below zero is absolute zero, and why this number?

$(m+x)\ (m-x)$

Reciprocal of $2/7$.

Solve $3 : 12 = 16 : x$.

Reduce .395, .005 to percentage.

If PV is constant how is P affected by doubling V?

Equation, $y = ax - b$. Solve for x. What is y equal to when $x = 0$?

Students who show averages below fifty per cent have their records carefully scrutinized and all then interviewed. Many at once agree that it is wise for them to drop the subject, while others protest and are sure they can carry the work. No one is compelled to drop out. Out of 171 taking the test this year, forty were below fifty per cent; twenty-two of these agreed that they were not properly prepared and at once entered some other class. Of the remaining eighteen who insisted on going on, nine failed in the first four weeks, while the other nine all were making good.

Almost none of those passing the efficiency test with marks above fifty per cent have proven unable to carry the work, so far as preparation and ability is concerned.

Records are being kept so that in a few years it can readily be ascertained how the different high schools sending students to the university rank in these tests; and special effort will be made to cooperate as as to secure the greatest possible benefit to all concerned.

"Some Everyday App'ications of Acoustical Principles," F. R. Watson, University of Illinois: One of the everyday axioms concerning fishing is not to talk. "Don't talk or you'll scare the fish" is the usual statement. Theory shows conclusively that sounds generated in the air are almost totally reflected on reaching the water. Experiments made while fishing show that it is not the noise of talking but noises produced when they are transmitted to the water that scare the fish. Sitting still in the boat and talking loudly produced no effect on nearby fish, but the slightest scraping of the feet on the bottom of the boat sent them scurrying away.

An interesting and perhaps valuable application of diffraction has been made by the author[1] following some experiments made by Lord Rayleigh.[2] A megaphone with a rectangular aperture about 2 in. by 6 in., when held with this "slit" vertical spreads the sound waves vertically but scarcely affects their horizontal spread dispersion. This megaphone is well adapted to addressing a crowd on bleachers at an athletic meet as the sound waves will be carried to all the bleachers at once.

"The Automobile in Physics," H. C. Krenerick, Milwaukee, Wis.: Practically every principle in mechanics, heat and electricity finds some illustration or application in the automobile. Attempts to use the automobile in instruction by means of cuts and slides proved its value for this purpose, but the results were so unsatisfactory that it was decided to get the real thing.

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[1]*Physical Review*, Vol. II, page 244, 1918. *Scientific American*, May 24, 1919.
[2]*Philosophical Magazine* Vol. 6, page 289, 1903.

After many months of effort and disappointment a 1917 model roadster was secured, the body removed and the chassis completely torn down, cleaned and reassembled in my laboratory. With a hack saw portions of the castings and housings were cut away so that the action of every part was clearly visible. The different parts of the machine were painted distinctive colors so that the tracing of the fuel supply system, electric wiring, etc., could be easily followed.

Thus far, the value and interest of the work which has been done with this car have been extremely gratifying. Further experience will doubtless increase its usefulness.

"The Use of the Electron in Elementary Physics," Daniel L. Rich, University of Michigan: In spite of the universal belief in the electron theory, and a considerable knowledge of the subject by all physicists, almost none of the elementary textbooks in physics make any use of that theory in explaining simple electrostatic and magnetic phenomena. The use of the electron in elementary science is attended with no greater difficulties than the use of atoms and molecules, and such use will certainly clarify, and simplify much that the older methods of explanation leave out.

The idea of the electron should be introduced at the very beginning of the study of electricity; preferably in the simpler phenomena of electrostatics. The notion of the neutral atom with its central, positive nucleus and surrounding mobile, negative electrons; positive and negative charges due to loss and gain of electrons; attraction between nucleus and electrons but repulsion between electrons; transfer of electrons through conductors but not through insulators, all these are most readily grasped by the high school student.

Similarly the electric current as a flow of electrons is not only scientifically accurate, but much more tangible, and easier of comprehension than any other notion. A clear understanding of electrical potential is perhaps impossible to young beginners, but there is no more need of emphasizing electrical potential than gravity potential. The analogy between electrical pressure and water pressure is so close that it may be sufficient to speak of electrical pressure under all conditions and leave the term potential for more mature consideration.

The assumption of a magnetic field around a moving electron immediately connects magnetic and electro-magnetic phenomena, and permits a clear picture of how a piece of iron is magnetized by bringing the orbits of the electrons in parallel planes.

The electron won't explain everything, but the difficulties it presents are not so numerous as those presented by older theories; and when it can be used it results in an explanation readily plausible and intelligible to even a beginner.

"Testing a Class for Color Blindness," Chas. M. Turton, Bowen High School, Chicago: The lack of a lantern made it impossible for Mr. Turton to present the method as he had intended, so he contented himself with a very brief explanation and a statement of his results. He had found no unmistakable cases of color blindness in some two hundred pupils tested.

Report of the Reorganization Committee, A. W. Augur: In response to the questionnaire sent to two hundred physics teachers fifty-eight replies were received. First choices were as follows: Ability aim, 30, or 51.7 per cent; knowledge aim, 15, or 25.9 per cent; appreciation aim, 13, or 22.4 per cent. The votes on the seven unclassified aims agreed very well with this vote: Initiative, 29.8 per cent; logical thinking, 22.8 per cent; appreciation of environment, 22.8 per cent; scientific attitude,

10.5 per cent; information, 3.5 per cent; science of physics, 5.3 per cent; moral law, 5. 3. per cent.

The next step will be to secure a vote on the subject matter of a standard course in physics, and to devise methods of testing results obtained by the different methods of instruction. There will also be an earnest effort made to encourage the trying out of new methods.

In accordance with the recommendation of the chairman, three committees were appointed to take up these three lines of work for the coming year:

I. To determine subject matter of course, C. L. Vestol, Chicago, Chairman.

II. To supervise and suggest experimentative in methods, H. C. Krenerich, Milwaukee, Chairman.

III. To suggest tests to determine how far physics teachers are realizing their aims, Fred R. Gorton, Ypsilanti, Mich., Chairman.

These chairmen were authorized to select additional members of their committees.

Officers for the ensuing year were elected as follows: Chairman, H. Clyde Krenerich, N. D. H., Milwaukee; vice chairman, Chas. T. Phipps, State Normal, DeKalb, Ill.; secretary, Glenn W. Warner, Englewood High, Chicago.

Adjourned.

A. W. Augur,
Secretary.

CLASSROOM SAYINGS.

What is a nebula?

One kind of nebula is a nebula hypothis.

What is centrifical force and give an example?

A centrifical force is one equal all around, when hitting a ball the force on it is ever the same until it lands.

Scientrific force is that which changes size and shape of a body as the spring balances the weight changes the shape and size of the spring.

Scientifical force is that which does not require the energy of man for example electricity.

Centrifugular force is a force acting on one point called the center such as the works of a clock or automobile.

Cyntrivical force is a force that goes around a certain axis. The electric fan for example.

Saturated air is air that has been raised to boiling and exploded into vapor.

The artic circle bounds the fridget zone.

A screw is an inclined plane with treads on it.

When melted sulfur gets very hot it becomes vicious (viscous).

A river drops waists and makes furtal land. It also makes leveys and a terrass.

Sublimation is when a solid changes to a gas in the form of a liquid.

Moisture gets into the air by evaporation, respiration and sublimation.

The principle of dry farming is that they put a dry place on the wet soil.

Here's a good one from the classical department:

Our classical head was explaining the meaning of "metempsychosis" or the transmigration of souls, in connection with the sixth book of the Aeneid.

After listening awhile, one of the seniors piped up and asked:

"Is that the same thing as the Feudal System?"

PROBLEM DEPARTMENT.

Conducted by J. O. Hassler,
Crane Technical High School and Junior College, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. If you have any suggestion to make, mail it to him. Address all communications to J. O. Hassler, 2337 W. 108th Place, Chicago.

SOLUTION OF PROBLEMS.

631. *Proposed by R. T. McGregor, Elk Grove, Calif.*

If $a : b = c : d$

Show that $a^4d^4 - a^2b^2d^4 + b^4c^2d^2 - b^4c^4 = 0$

I. *Solution by William H. Brown, Amherst High School, Amherst, Mass.*

$ad = bc.$

$\therefore a = bc/d.$

Substituting:

$(bc/d)^4d^4 - (bc/d)^2b^2d^4 + b^4c^2d^2 - b^4c^4 = b^4c^4 - b^4c^2d^2 + b^4c^2d^2 - b^4c^4 = 0.$

II. *Solution by N. Barotz, New York City.*

Let $a/b = c/d = k$

Then $a = bk$ and $c = dk$.

Substituting these values in the given equation:

$b^4k^4d^4 - b^4k^2d^4 + b^4k^2d^4 - b^4d^4k^4 = 0.$

$0 = 0.$

Also solved by Annabel Donnelly, Hazel C. Jones, J. S. Morris, H. L. Neher, A. Pelletier, Clytus Robinson, Henry Ruzicki, M. G. Schucker, T. F. Tyler, Oscar M. Togle *and* Herbert C. Whittaker.

632. *Proposed by Walter R. Warne, Carlisle, Pa.*

Determine k so that one root is twice the other in

$$(2k-1)x^2 + (k+3)x + (k^2-2k+1) = 9.$$

I. *Solution by N. Barotz, New York City.*

Solving the general quadratic equation and placing one root equal to twice the other:

$(-b + \sqrt{b^2-4ac})/2a = (-b - \sqrt{b^2-4ac})/a.$

Therefore $2b^2 = 9ac.$

The corresponding values in the given equation have the same relation, if one root is to be twice the other.

$$2(k+3)^2 = 9(2k-1)(k^2-2k-8)$$
$$18k^3 - 47k^2 - 138k + 54 = 0$$
$$k = .354;\ 4.253;\ \text{and } -1.997.$$

There was an error in the statement of this problem. The second member of the equation should have been zero. By coincidence, the author of the solution below has made the opposite mistake and solved the problem as submitted to the editor by the Proposer.—*Editor.*

II. *Solution by Herbert C. Whitaker, Philadelphia.*

If one root of the quadratic $ax^2 + bx + c = 0$ is twice the other root, then $9ac = 2b^2$.

Hence substituting the given coefficients:

$$9(2k-1)(k^2-2k+1) = 2(k+3)^2$$

Which reduces to

$$18k^3 - 47k^2 + 24k - 27 = 0.$$

Which can be arranged

$$(k-2.31505)(18k^2-5.3291k+11.6629) = 0.$$

The only real value of k is 2.31505
and the roots are

$$-3c/b = -.97611$$

and

$$-3c/2b = -.48805.$$

Also solved by J. S. Morris, A. Pelletier, *and* M. G. Schucker.

633. *Proposed by N. P. Pandya, Amreli (Kathiawad), India.*

Draw a straight line bisecting each of two coplanar triangles. Under what circumstances will its intercepts within the triangles be equal?

No solutions to this problem were received.—*Editor.*

634. *Proposed by Herbert C. Whitaker, Philadelphia, Pa.*

Find the value of $(-\pi)^\pi$.

I. *Solution by the Proposer.*

$$\begin{aligned}(-\pi)^\pi &= \pi^\pi(\cos\pi+i\sin\pi)^\pi\\ &= \pi^\pi(\cos\pi^2+i\sin\pi^2)\\ &= 36.4625(\cos 9.8696+i\sin 9.8696)\\ &= 36.4625(\cos 565°29'+i\sin 565°29')\\ &= -32.915-15.688i\end{aligned}$$

II. *Solution by Norman Anning, Orono, Maine.*

$(-\pi)^\pi = \pi^\pi(-1)^\pi$ = tensor × versor.

Now $(-1) = e^{(2k+1)i\pi}$ where $k = 0, \pm1, \pm2, \pm3, \pm4$, etc.

$$\begin{aligned}(-1)^\pi &= e^{(2k+1)i\pi^2}\\ &= \cos(2k+1)\pi^2+i\sin(2k+1)\pi^2.\end{aligned}$$

Consequently, the given combination of symbols represents a set of complex numbers having the constant modulus,

$$|\pi^\pi| \quad (=36.46 \text{ nearly})$$

and such that the arguments of successive numbers differ by π whole revolutions.

The given expression cannot have any real values for if integers h and k could be chosen so that

$$(2k+1)\pi^2 = h\pi,$$

π would be a root of a quadratic equation with integral coefficients.

But, by Lindemann's Theorem, π is not the root of any algebraic equation with integral coefficients.

Similar argument shows that no value of the expression is repeated for a different k.

Hence $(-\pi)^\pi$ has a single infinity of complex values.

Also solved by A. Pelletier *and one incorrect solution received.*

635. *Proposed by Walter R. Warne.*

Find the maximum value of $(\csc^2\theta-\tan^2\theta)/(\cot^2\theta+\tan^2\theta-1)$.

I. *Solution by R. T. McGregor, Elk Grove, Calif.*

The expression may be written as

$$(\tan^2\theta-\tan^4\theta+1)/(\tan^4\theta-\tan^2\theta+1) = -1+2/(\tan^4\theta-\tan^2\theta+1),$$

which will be a maximum when $\tan^4\theta-\tan^2\theta+1$ is a minimum. The minimum value of this function is 3/4 (when $\tan\theta = \sqrt{2}/2$). Hence the maximum value of the given expression is $-1+8/3 = 5/3$.

II. *Solution by A. Pelletier, Montreal, Can.*

Let $m = \tan^2\theta$ and the given expression becomes

$$(1/m+1-m)/(1/m+m-1) \quad\text{or}\quad (1+m-m^2)/(1-m+m^2) = k, \text{ say.}$$

Then $(k+1)m^2-(k+1)m+k-1 = 0$; m being real.

$$(k+1)^2-4(k+1)(k-1) \geqq 0.$$

Hence, k varies from -1 to $5/3$. Therefore k, or the given expression, has 5/3 for maximum value.

Also solved by N. Barotz (*using calculus*).

Errors.

Second equation of problem 636, page 90 (January, 1920) should have the third term read xy instead of xy^2.

Problem 637 should conclude with AB/C *to the n-th power* instead of *multiplied by n*.

In the same issue the editor's statement numbered V in the solutions of problem 622 is incorrect and worthless.

PROBLEMS FOR SOLUTION.

646. *Proposed by A. Pelletier, Montreal, Can.*

Find the remainder of the division of 6^{592} by 11.

647. *Proposed by Walter R. Warne, State College, Pa.*

$S_1, S_2, S_3, \cdots S_p$ are the sums of p arithmetical progressions, each continued to n terms; the first terms are $1, 2, 3, \cdots p$, respectively, and the common differences $1, 3, 5, \cdots 2p-1$. Prove that $S_1+S_2+S_3+ \cdots +S_p = np(np+1)/2$.

648. *Proposed by J. W. Lyle, Hartwell High School, Cincinnati, O.*

In the right dihedral angle formed by a floor and a wall is built a rectangular coal bin four feet high which extends three feet from the wall. What are the possible positions of a ladder eleven feet long that will touch the wall, the bin and the floor at the same time?

649. *Proposed by Walter R. Warne.*

If the inscribed circle of the triangle ABC passes through the center of the circumscribed circle, then

$$\cos A + \cos B + \cos C = \sqrt{2}.$$

650. *Proposed by Norman Anning, Orono, Me.*

Two hunters start from the same camp. A goes one mile east and then one mile N 18°E. B goes one mile N 30°E and then one mile N 54°E. Find the distance and direction of B from A.

News Items.

It pleases us to note that Norman Anning, a long time contributor to this department, has joined the faculty of the University of Maine.

R. M. Mathews, who has also contributed much to the success of this department, is now a member of the faculty of the University of Minnesota.—[*American Mathematical Monthly.*

NOTICE.

We are sorry to announce that Mr. William L. Eikenberry of the University of Kansas, for many years at the Head of our Botany Department, has been obliged to withdraw on account of the press of other duties. Mr. Worralo Whitney, who for a long period has been conducting the Zoology Department, has been given, at his request, the Department of Botany. For the Editor of the Zoology Department we have been exceedingly fortunate in securing Mr. Harold B. Shinn of the Schurz High School, Chicago.

SCIENCE QUESTIONS.

Conducted by Franklin T. Jones.

The Warner & Swasey Company, Cleveland, Ohio.

Readers are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, 10109 *Wilbur Ave., Cleveland, Ohio.*

Examination and Test Papers.

Please send examination papers on any subject or from any source to the Editor of this department. *He will reciprocate by sending you such collections of questions as may interest you and be at his disposal.*

Send in any tests you are trying. Others will be interested in what you are doing.

State teachers' examination papers and State examination papers for pupils are also much desired. What States have such examinations? Please inform the Editor how and where they may be obtained.

ACKNOWLEDGMENTS.

The receipt of examination papers and examination information is gratefully acknowledged from the following:

J. T. Ross, Deputy Minister of Education, Edmonton, Alberta.

H. J. Silver, Secretary-Superintendent, Protestant Board of School Commissioners, Montreal.

W. S. Carter, Chief Superintendent of Education, Fredericton, New Brunswick.

A. H. MacKay, Superintendent of Education, Halifax, Nova Scotia.

R. H. Blacklock, Registrar, Dept. of Education, Regina, Saskatchewan.

L. J. Willis, Superintendent of Education, Victoria, British Columbia.

C. M. McCann, Chief Clerk, Dept. of Education, Winnipeg, Manitoba.

P. M. Dysart, Schenley High School, Pittsburgh, Pa.

QUESTIONS AND PROBLEMS FOR SOLUTION.

337. *Proposed by A. Haven Smith, Riverside, Calif.*

An enemy tank is observed 400 yards away. It is advancing at a speed of 6 miles per hour. Assume a muzzle velocity of 259 feet per second and vacuum conditions.

(a) What will be the time of flight of the shell?

(b) How far will the tank have moved during the flight of the shell?

(c) What is the correct angle of elevation?

Proposed by the editor.

Let us hear from some of our artillery friends in answer to the question.

(d) Are the above conditions practical ones? If not, why not?

(e) What would be a statement in accordance with actual conditions?

(d) What would be the solution in case "vacuum conditions" were not assumed?

EXAMINATIONS.

Submitted by W. S. Carter, Chief Superintendent of Education, Fredericton, New Brunswick.

High School Entrance Examinations, *New Brunswick.*

Nature Study, Agriculture and Health.

Time—2 Hours.

F. A. Good.

Values.

15 1. Write some observations you have made concerning *one* of the following: (*a*) a destructive insect, (*b*) a plant disease, (*c*) troublesome bird.

20 2. Name six different species of birds that are permanent residents of New Brunswick. Which of these are of value to man, and in what way?

15 3. Name four of the earliest wild flowers found in your neighborhood. State where they are found and make a drawing of one of them.

15 4. Write a paragraph on methods employed on the farm or in the garden to rid the land of weeds. Why is this necessary? Show clearly why this same process must be repeated year after year.

or

Write a paragraph on any observation or experiment you have made concerning weeds.

20 5. Make a list in the order of their importance of the domestic animals found on the farms of New Brunswick. Discuss usefulness of first named.

15 6. Describe accurately the planting and cultivation of one farm crop.

or

Describe the planting and cultivation of one product of the garden.

15 7. What are the functions of the lungs, liver and kidney? What is the effect of alcohol on each?

20 8. What changes must the different classes of food undergo before they may be used in the human body? Why are these changes necessary?

15 9. Give theory and rules governing the practice of (*a*) bathing, (*b*) chewing food.

150

June, 1919.

Normal School Entrance Examinations, *New Brunswick.*

Nature Study.

Class I. Time—1 Hour, 30 Min.

(Questions are of equal value.)

1. Give approximate dates of the return of six migratory birds that you have observed this year. Explain as far as you can why these birds left our Province and why they returned. Argue as to whether they should be called New Brunswick or southern birds.

2. Why should bird life be studied in the public schools? Describe the English Sparrow and one less common resident bird.

3. Show how the following anticipate the winter, i. e., how they prepare for it: (*a*) a deciduous tree; (*b*) a perennial that dies to the ground each fall; (*c*) an annual.

4. What plants found in New Brunswick but not cultivated are used for food for human beings? What animal forms not reared by man are also used for same purpose? What important difference is to be noted between the food of animals and that of plants?

5. Name four weeds that persist about human dwellings in spite of efforts to exterminate them. Describe one and draw one. Explain as far as you can why it is difficult to eradicate these plants.

6. Describe two experiments or observations which you have made. one relating to germination of seed or other garden work, and the other to insect life.

July, 1919.

SOLUTIONS AND ANSWERS.

318. *Proposed by Hanor A. Webb, Nashville, Tenn.*

The atomic weight of the gas helium is 4. In discussing the use of this gas as a substitute for hydrogen in balloons, the *Scientific American* has recently correctly stated that helium was only twice as heavy as hydrogen. Explain this apparent discrepancy.

Solution by the proposer.

An atom of helium is four times as heavy as an atom of hydrogen. But hydrogen, as a gas, exists in the molecular form with its atoms in pairs, as H_2, while helium, being one of the "inert gases" without combin-

ing power, exists in the atomic form, as He_1. Thus, a given volume of He_1 is only twice as heavy as the same volume of H_2.

335. *Proposed by W. L. Malone, Tacoma, Wash.*

"If a man can jump 3 feet high on the earth, how high could he jump on the moon, where g is 1/6 as much?"

Solution by F. D. Mack, La Crosse, Wisconsin.

1. $v_1 = \sqrt{2a_1s_1}$

Because a body starting from rest with uniform acceleration, the change in velocity in a given distance is numerically equal to the square root of twice the product of the acceleration and the distance.

2. $v_2 = \sqrt{2a_2s_2}$

3. $\therefore \dfrac{a_1}{a_2} = \dfrac{s_2}{s_1}$

Because the initial velocity v_1 on the earth is the same as the initial velocity v_2 on the moon.

By substitution,

4. $\therefore 1/(1/6) = s_2/3$

The product of the means equals the product of the extremes.

5. $\therefore 1/6s_2 = 3$

6. $\therefore s_2 = 18$, the height he can jump on the moon.

Solution by W. L. Malone, Tacoma, Wash.

First on the earth:

$v_1 = \sqrt{2gs_1} = \sqrt{6g}$

Let F = the average value of the jumping effort.

$\therefore$ The force to which v_1 is due $= F - mg$, where m = the man's mass, hence

$(F-mg)t_1 = mv_1 = m\sqrt{6g}$

$\therefore F/m = \sqrt{6g}/t_1 + g$

Now F/m = the acceleration produced in m by F, when unopposed by gravity, and hence is independent of g, though given here in terms of g.

Second, on the moon:

We assume that the man makes the same effort here as before, hence,

$[F - m(g/6)t = mv$

$\therefore v = (F/m - g/6)t = (\sqrt{6g})/t_1 + 5g/6)\ t$

$\therefore 2(g/6)s = (\sqrt{6g}/t_1 + 5g/6)^2t^2$

Or $s = 3(\sqrt{6g}/t_1 + 5g/6)^2t^2 = 3g(\sqrt{6}/t_1 + 5\sqrt{g}/6)^2t^2$

(But little consideration will show that $t < t_1$.)

Now if d is the distance through which F acts, it is the same in both cases; so also F, hence the work done is the same in both; the equation of energy is therefore,

$E = mgd + 3mg = m(g/6)d + (1/2)mg(\sqrt{6}/t_1 + 5\sqrt{g}/6)^2t$

$\therefore 5d/6 + 3 = s/6$ or $s = 18 + 5d$.

Hence s is a function of d.

Hence also two men who can jump to the same height on the earth, may not be able to jump to the same height on the moon and vice versa.

ARTICLES IN CURRENT PERIODICALS.

American Journal of Botany, for December; *Brooklyn Botanic Garden; $5.00 per year, 60 cents* a *copy:* "Influence of Sugars on the Growth of Albino Plants," L. Knudson and E. W. Lindstrom; "Variations in Pleurage Curvicolla (Wint.) Kuntze," J. L. Weimer; "Inheritance of Sex in Mercurialis Annua," Cecil Yampolsky; "Germination and Further Development of the Embryo of Zea Mays Separated of the Ermndosperm," Demetrius Ion Andronescu.

American Mathematical Monthly, for December; *Lancaster, Pa.: $4.00 per year, 50 cents a copy:* "Mathematics and Statistics with an Elementary Account of the Correlation Coefficient and the Correlation Ratio,"

E. V. Huntington; "Meeting of the Minnesota Section"; "The Work of the National Committee on Mathematical Requirements"; Questions and Discussions: "Dup'n's Theorem," D. C. Kazarinoff; "A Property of Homogeneous Functions," J. E. Trevor; "Graphical Constructions for Imaginary Intersections of Line and Conic," R. M. Mathews.

Journal of Geography, for January; *Broadway at 156th Street, New York; $1.00 per year, 15 cents a copy:* "New Boundaries of Austria, Capital Cities," F. Hamburg; "Finding Farms for Returned Soldiers," Ona I. Nolan; "Black Diagrams," A. K. Lobeck.

Literary Digest, for February 7; *New York City; $4.00 per year, 10 cents a copy:* "Alien and Sedition Bills of 1920"; "Socialism on Trial at Albany"; "The Kansas Strike Cure"; "Germany's Mysterious Army"; "Turkey to Remain in Europe"; "The Best Artificial Limbs Yet."

National Geographic Magazine, Washington, D. C.; $3.00 per year, 35 cents a copy: "The Removal of the North Sea Mine Barrage" (28 illustrations); Noel Davis; "Skiing Over the New Hampshire Hills," (37 illustrations), Fred H. Harris; "Winter Rambles in Thoreau's Country" (15 illustrations), Herbert W. Gleason; "Where the World Gets Its Oil" (21 illustrations), George Otis Smith.

Nature-Study Review, for December; *Ithaca, N. Y.; $1.00 per year, 15 cents a copy:* "Cooty, a Pet Coati," Alfred E. Emerson, Jr.; "Night Fairies' Rendezvous," E. Eugene Barker; "Chamois at Home," Peter A Mattli; "Pocket Gopher," Mae Creswell; "Virginia Deer," George H. Russell; "Our Pet Chipmunk Uncas," Jay Traver; "Notes on the Blacksnake," Helen H. Humphrey; "The Grizzly Bear," Lois I. Webster; "Raccoon," George B. Happ; "Burrowing Raccoons," L. B. Cushman.

Photo-Era, for January; *Boston, Mass.; $2.00 per year, 20 cents a copy:* "Technical Knowledge Behind the Photo-Counter," Photographic Dealer; "Architectural Traditions for the Photographer," Edward Lee Harrison; "Combination-Printing," The British Journal; "What Photography Has Done For Me," Michael Gross; "Winter-Landscapes," William S. Davis; "The Airplane in Pictures," Latimer J. Wilson; "Price Cooperation," Edgar M. Atkins; "Equipment for Color-Photography," Robert M. Fanstone; "Photographing Children," Wilson Todd; "A Photographic Gambol," L. B. Flint; "At-Home Lantern-Screens," Lanternist.

Physical Review, for December; *Ithaca, N. Y., $7.00 per year, 75 cents a copy:* "The Optical Constants of Liquid Alloys," C. V. Kent; "On the Maintenance of Vibrations of Wires by Electrical Heating," N. C. Krishmaiyar; "On the Diffraction Theory of Microscopic Vision," Phanindra Nath Ghosh; "Resonance and Ionization Potentials for Electrons in the Monatomic Gases Argon, Neon, and Helium," H. C. Rentschler; "On the X-Ray Absorption Frequencies Characteristic of the Chemical Elements," William Duane and Kang-Fuh-Hu; "On the X-Ray Absorption Frequencies Characteristic of the Chemical Elements," William Duane and Takeo Shimizu; "The Relation between the Intensity of General X-Radiation and the Atomic Number of the Anticathode," William Duane and Takeo Shimizu.

Popular Astronomy, for February; *Northfield, Minn.; $4.00 per year:* "Various Suggestions Relating to Stellar Evolution, Planetary Genesis, and Hyperbolic Comets" (with Plate III), William H. Pickering; "First Study of Heavenly Bodies, Lesson II," Mary E. Byrd; "Celestial Photography for Amateurs by an Amateur (with Plates IV and V), Dean B. McLaughlin; "Sirius at Sea," Charles Nevers Holmes; "The French Republican Calendar and Some Others," Roscoe Lamont; "The Decimal System for Time and Arc for Use in Navigation," Charles E. Manierre; "Report on Mars,No. 22" (with Plate VI), William H. Pickering; "Yerkes Observatory 1919," Edwin B. Frost.

School Review, for February; *University of Chicago Press $1.50. per year, 20 cents a copy:* "The Ben Blewett Junior High School of St. Louis—Part II," R. L. Lyman; "A Study of Applied Music," Frank A. Scott; "Wherewith Shall We Be Clothed?" Anonymous; "Compulsory Education in the Southern Colonies," Marcus W. Jernegan; "Vocational Guidance and the Theory of Probability," Harry D. Kitson.

BOOKS RECEIVED.

A Field and Laboratory Guide in Physical Nature-Study, by Elliot R. Downing, University of Chicago. 109 pages. 16.5×21.5 cm. Paper. 1920. $1.10. The University of Chicago Press.

Laboratory Exercises in Chemistry, by Charles E. Dull, South Side High School, Newark, N. J. 224 pages. 19.5×24.5 cm. Paper. 1919. Henry Holt & Company, New York City.

General Mathematics, by Raleigh Scharling, Lincoln School of Teachers College, Columbia University, and William D. Reeve, University High School, University of Minnesota. Pages xvi+488. 13.5×19 cm. Cloth. 1919. $1.48. Ginn & Company, Chicago.

The Geography of the Ozark Highland of Missouri, by Carl O. Sauer. Pages xviii+245+51 half-tones. 16.5×24 cm. Cloth. 1919. $3.15. The University of Chicago Press.

Plane Geometry, by Mabel Sykes, Bowen High School, Chicago, and Clarence E. Comstock, Bradley Polytechnic Institute, Peoria, Ill. Pages xii+322. 13.5×20 cm. Cloth. 1919. Rand McNally & Company, Chicago.

Elements of Vector Algebra, by L. Silberstein, University of Rome. 42 pages. 14×22 cm. Cloth. 1919. $1.60. Longmans, Green & Company, New York City.

Junior Science, by President John C. Hessler, The James Millikin University. Pages xii+243. 14.5×19.5. Cloth. 1920. Benj. H. Sanborn & Company, Chicago.

Pamphlets Received.

Bulletin No. 72, Bureau of Education, an Abstract of the Report on the Public School System of Memphis, Tenn.

Bulletin No. 44, Bureau of Education, Modern Education in China.

Bulletin No. 51, Bureau of Education, The Application of Commercial Advertising Methods to University Extension.

Manual for Conservation of Vision Classes, National Committee, 130 East 22nd St., New York City.

Bureau of Educational Research, Bulletin No. 2, The University of Illinois.

Teachers' Salaries and Salary Schedules in the United States, The National Education Association, by E. S. Evenden, Washington, D. C.

ALBERTS TEACHERS' AGENCY.

For the past few years the Albert Teachers' Agency, 25 E. Jackson Boulevard, Chicago, has published a pamphlet for gratuitous distribution to teachers, entitled "Teaching as a Business." The new edition of this pamphlet has very interesting chapters on "Forecast," "Scarcity of Teachers," "Letter of Application," and other timely topics. More than four thousand of these booklets were called for last year by Professors of Education in Colleges and Normal Schools who used them in their class rooms. The discussion of the salary question is forceful and vigorous.

BOOK REVIEWS.

Number by Development, Vol. II, Intermediate Grades, by John C. Gray, A. M., Superintendent of Schools, Chicopee, Mass. Pages xxii+486 +xi. 13×19 cm. 1919. J. B. Lippincott, Philadelphia.

The purpose of this book is to furnish a working outline in detail of class work in common fractions in accordance with development ideals and suggestions in denominate numbers. The development theory and its use and the principles in teaching practice are explained fully. In addition to the details of subject matter, the teacher is shown the sequence of teaching steps, the form of objective work and methods of drawing pupils' attention to the line of development thought and holding it there for a properly sustained consideration of the unit of truth involved.

H. E. C.

Div-a-let, Second Edition, by W. H. Vail, A. M., M. D. Pages 70. 12×20 cm. Paper covers. The Revell Company Press.

This book contains 322 examples in division in which letters are used in the place of digits. The problem is to obtain the word or series of letters hidden in the example. In the words of the author, it is "A pastime or mental diversion, mostly intended for those who are fond of such things." The exercise of considerable ingenuity is required to find the hidden word, and some knowledge of number combinations may be gained. Copies, price 50 cents each, may be obtained of the author. Address 141 Second Avenue, Newark, N. J.

H. E. C.

Correlated Mathematics for Junior Colleges, by Ernst R. Breslich, Head of the Department of Mathematics in the University High School, The University of Chicago. Pages xiii+301. 14×20 cm. $1.25. 1919. The University of Chicago Press.

The work usually covered in separate course in college algebra and analytic geometry are combined in this book. As in the other books in this series, mathematical topics which are naturally related to each other are closely associated. The author has done this with such a clear perception of mathematical facts and skill in uniting them that the student may gain a ready knowledge of principles and processes and apply them intelligently in any problem without stopping to consider whether he shall use algebra or geometry. The definitions, explanations and illustrations are sufficiently precise and exact, but are put in everyday language which can be readily grasped by the student.

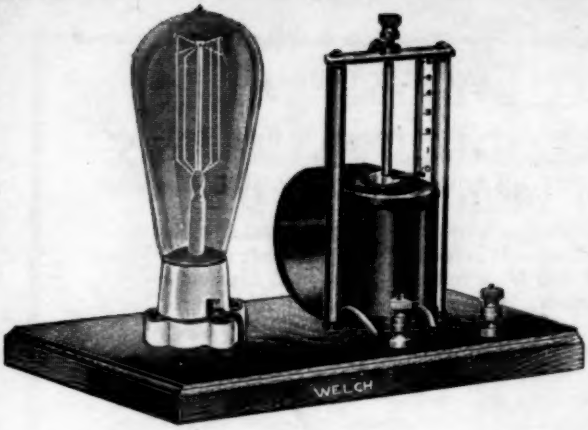
H. E. C.

A Short Course in College Mathematics, by Robert E. Moritz, Ph. D., Professor of Mathematics in the University of Washington. Pages ix+236. 13×19 cm. 1919. The Macmillan Company, New York.

For the essentials of algebra and trigonometry and a working knowledge of graphs and coördinate methods, this book offers a most satisfactory choice of subject matter and applied problems. While the material is greatly condensed it includes all the principles essential for analytic geometry and calculus, or engineering and other fields of applied science.

The problems are closely correlated with the descriptive matter, and not only emphasize the fundamental principles but also give the student the ability to use his knowledge in doing things in a practical way. The use of this book will certainly give students firm grounding for future work and shorten the time of preparation.

H. E. C.


WELCH

Vocational Agricultural Education, by Home Projects, by Rufus W. Stinson, State Supervisor of Vocational Education in Massachusetts. Pages xxxviii+468. 13×18 cm. 307 figures. $2.50. 1919. The Macmillan Company.

The book is written for students of vocational agricultural methods used in schools and project teaching. It is for the young teacher of vocational agriculture and is packed full of argument, data, and illustrative examples pertaining to the work. It is meant to be and is a source book in this subject.

The illustrations are very numerous and are all illustrative of actual project work. They may form a good course of instruction in themselves, for they are protographs and well chosen to tell a progressive story. We heartily recommend those interested in agricultural education to investigate this book. W. W.

Elementary Biology, An Introduction to the Science of Life, by Benjamin C. Gruenberg, Julia Richman High School, New York. Pages x+528, 262 illustrations. 13x18 cm. 1919. Ginn & Company.

As a rule, in the smaller schools, where one year is given to biology, the work is divided between botany and zoology. Real courses in biology are seldom given. The practice of giving botany and zoology as half-year courses is bad for the reason that the subjects are large and teachers seldom have the courage to vigorously confine their work to just what can be well done. There is always the tendency to cover too much of the field in the short time available with the result that the work is superficial and hurried. It is no wonder that botany and zoology have been losing ground.

One reason for bad results in biological courses has been due to the textbooks. Uusally books more suitable for a year's work in each subject are used. There are very few books suitable for half-year courses and still fewer books in which animals and plants are combined in a single course, as biology. In *Gruenberg's Elementary Biology* teachers have an opportunity to use a worth-while book. It combines animals and plants in one course under biological topics. The subjects chosen are most important and the treatment clean-cut. The text is abundantly illustrated with figures that help tell the story. We unhesitatingly recommend the book to teachers of half-year courses in botany and zoology as giving an opportunity for doing more vital, interesting and better work.

Before closing this review, however, attention should be called to certain features of the book. It is written by a New York teacher and therefore is made to suit the peculiar conditions prevailing in that state. Human physiology and hygiene are included. Most schools nowadays include physiology in the general science course and give it in the first year of the high school. We feel also that the book is too crowded and the presentation rather too "meaty" for students of the ninth and tenth grades. However, this is not so bad a fault as being too wordy and discursive, a fault of many texts whose authors, in trying to make the thought clear to young students, simply confuse the thought with too much explanation. The wise teacher will avoid the faults of the inclusion of physiology which has already been given and the overcrowding by omitting what cannot be well done in the time at his disposal. Good textbooks are too scarce to reject because of faults so easily remedied.

W. W.

Plant Production; Part I, Agronomy; Part II, Horticulture; by Ransom A. Moore, University of Wisconsin, and Charles P. Halligan, Michigan Agricultural College. Pages 428 with 210 illustrations. 12x16 cm. 1919. American Book Company, Chicago.

This textbook is written for use in schools providing for vocational instruction in agriculture. The authors have aimed to make the book "useful, practical and of immediate application."

The style of the book is simple, clear and direct. The subject matter appears to be well chosen for the purpose of the book. The illustrations are good and help the text tell the story. As the title suggests, Part I deals with the grain, hay and other crops of the farm, while Part II takes up the garden and orchard, including the home and its surroundings. The treatment of each topic is very comprehensive and practical. We think the authors have been successful in this undertaking and that the book is worthy of careful consideration for the grade and kind of school work for which it is intended. W. W.

An Introductory Course in Quantitative Chemical Analysis, with Explanatory Notes, Stoichiometrical Problems and Questions, by George McPhail Smith, Associate Professor of Chemistry in the University of Illinois. Pages x+206. 17x15.5x2 cm. Cloth. 1919. The MacMillan Company, N. Y.

This new manual of quantitative analysis is intended for use by beginners, who have presumably had a year of general chemistry and a course in qualitative analysis.

Part I deals with the general principles and with the special manipulations used in quantitative analysis. It is apparently intended both for a preliminary survey of methods and for frequent specific reference later on.

Part II treats of gravimetric analysis and Part III of volumetric analysis.

Part IV has eight pages devoted to stoichiometry.

Part V consists of questions.

An appendix deals with preparation of reagents, of analytical samples, and of apparatus. A logarithm table is also furnished.

The analyses selected for practice seem to be very well chosen. They cover a sufficient range so that all students, no matter what line of work they may ultimately specialize in, will find themselves well grounded in the fundamental methods of analysis.

The explanations of the reasons for the methods employed are excellent, see, for example, the notes, pages 89-96, in regard to the electrolytic determination of copper.

With this manual the instructor should be free to devote most of his time to the development of fundamental principles of the subject as the detailed instructions are so clear and so complete that the student of college caliber should find little difficulty in following them. F. B. W.

College Textbook of Chemistry, by W. A. Noyes, Director of the Chemical Laboratory of the University of Illinois. 1st Edition. Pages viii+370. 13.5x19x2 cm. Cross-section drawings. Cloth. 1919. Henry Holt & Company.

The first impression one receives on seeing this little book from the pen of the New President of the American Chemical Society is that there must be a second volume, so much smaller is it than the usual college text in general chemistry.

A glance at the measurements above or at the number of pages will at once apprise the reader of this review that the book is not much over half the usual size.

A careful study of the text, however, will show that it is full of meat, and that the author, with the courage of his convictions, has dared to omit the greatest lot of interesting things in order that the student who uses the text may have a real chance, not only to learn most of the subject matter included, but to get an adequate sense of things chemical as he studies the book.

To this end the order of subjects has been artfully chosen and the succession of topics is such as to lead to progressive growth in power to use and apply what has gone before. That the interrelation of topics may not be overlooked much cross referencing has been provided. This is not overdone but occurs frequently enough to give the earnest student every chance to link up the present topic with related antecedents.

The early introduction of comparatively recent chemical theory is noteworthy and in line with the best modern thought. Why should we follow the calf paths of the past instead of making straight the way? Such a short circuiting comes from the early teaching of the ionic theory (page 65) and the fairly consistent use of it thereafter. Valence is admirably presented at a comparatively early point (page 100). The hypothesis of Avogadro and its necessary consequences are well presented in the twelfth chapter.

Nor is the practical overlooked by the author in his enthusiasm for teaching the underlying theories of the subject. Every now and then we find some up-to-date, practical application of chemistry referred to and explained.

A somewhat out of the ordinary feature for a college text is the summary and set of questions at the end of each chapter. This is good pedagogy, however, and has been found valuable in high school texts.

In more ways than one the new text resembles some of the better high school texts. It frankly treats the student as a beginner, and recognizing that all beginnings are hard it tries to help him over some of the difficulties, without, however, coddling him too much. Many a college text has failed to recognize the need for this type of approach, with the result that only the brilliant student or the tireless plugger got much out of it.

College teachers of general chemistry will do well to consider this new text carefully, and many a high school teacher can improve his teaching if he will study its methods and its content.

It will be found especially helpful in applying modern concepts, like that of the electron, for example, to the consideration of the facts of chemistry. The author has shown much originality in the creation of this text and has blazed a trail that may well be followed, and perhaps smoothed up, by others.

Exercises in Chemistry, by William A. Noyes, Director of the Chemical Laboratory, and B. Smith Hopkins, Asst. Professor of Inorganic Chemistry, in the University of Illinois. 2nd edition. Pages vi+131. 12.5×19×1 cm. Cross-section drawings. Paper. 1917-1919. N. Y. Henry Holt & Company.

This revised edition of *Exercises in Chemistry* follows in part the order of treatment of the *College Textbook of Chemistry* reviewed above.

Its aims are similar, namely, to bring about thoughtful consideration of the facts of chemistry in the light of modern theories. The many leading questions interspersed with the directions help in this regard, as do the several hundred exercises for the classroom provided in the back of the volume. The directions are clear and concise, but not too brief for students of college age. The object or purpose of each experiment is usually indicated only by a brief title. In this respect, perhaps too telegraphic a style is employed, though in many cases the brief title sufficiently announces the nature of the experiment. In the latter portions of the book, as also in the textbook just reviewed, considerable space is devoted to the chemistry upon which schemes of qualitative analysis are based. This material affords excellent practice in applying the chemical knowledge that the student has gained, and even though he may not be intending to follow up the subject he can well afford to give the time to it. As the child is father to the man, so this little manual may have been the progenitor of the excellent college text which it preceded.

F. B. W.

DIRECTORY OF SCIENCE AND MATHEMATICS SOCIETIES.

Under this heading are published in the March, June, and October issues of this Journal the names and officers of such societies as furnish us this information. We ask members to keep us informed as to any change in the officiary of their society. This is extremely valuable information to all progressive teachers. Is your Society listed here? Names are dropped when they become one year old.

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sponding Secretary, Ally L. Marlatt, University of Wisconsin, Madison; *Assistant Treasurer*, E. S. Tillman, High School, Hammond, Indiana; the *Recording Secretary*, Harry O. Gillet, the University of Chicago, was elected last year for a two-year term. *Section Officers for 1920:*

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